JOURNAL OF THE

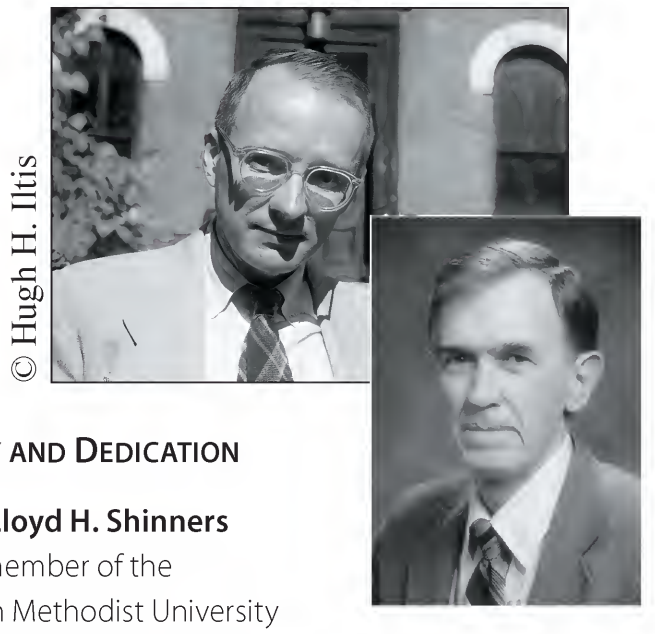
BOTANICAL RESEARCH INSTITUTE OF TEXAS

VOLUME 8, NUMBER 2, 25 NOVEMBER 2014

Journal of the Botanical Research Institute of Texas

J. Bot. Res. Inst. Texas *ISSN 1934-5259*

VOLUME 8 **NUMBER 2** **25 NOV 2014**



© Hugh H. Iltis

History and Dedication

1962—Lloyd H. Shinners (left), a member of the Southern Methodist University (SMU) faculty and a prolific researcher and writer, published the first issues of *Sida, Contributions to Botany* (now *J. Bot. Res. Inst. Texas*)

1971—William F. Mahler (right), professor of botany at SMU and director emeritus of BRIT, inherited editorship and copyright.

1993—BRIT becomes publisher/copyright holder.

2007—First issue of *J. Bot. Res. Inst. Texas.*

Mission and Goals

The BRIT Press seeks innovation and excellence in preparation, manufacture, and distribution of botanical research and scientific discoveries for the twenty-first century.

The BRIT Press—bringing out the best in botanical science for plant conservation and education.

Direction and Coverage

The BRIT Press considers original research papers concerned with classical and modern systematic botany, sensu lato, for publication in *J. Bot. Res. Inst. Texas.* All submissions are peer-reviewed. Guidelines for submissions are available from the BRIT Press website, http://www.britpress.org.

Bibliographical

Citation abbreviation for the *Journal of the Botanical Research Institute of Texas* is *J. Bot. Res. Inst. Texas* following the principles of B.P.H. (informally *JBRIT*).

International Standard Serial No. (ISSN 1934-5259)

Frequency of Publication

J. Bot. Res. Inst. Texas is published semiannually (summer/fall) as one volume by the Botanical Research Institute of Texas.

Copyright 2014
Botanical Research Institute of Texas (BRIT)

1700 University Dr.
Fort Worth, Texas 76107-3400, USA
817-332-7432; 817-332-4112 fax
Electronic mail: barney@brit.org; jbrit@brit.org

Editor: Barney Lipscomb
Assistant Editor: Brooke Byerley

Contributing Spanish Editor
Félix Llamas (Universidad of León, León, Spain)

Editorial Board
Harold Keller (BRIT)
Robert J. O'Kennon (BRIT)
Richard Rabeler (MICH)

Subscription Prices (2015)

$49. Personal (Individual/Family)
$38. Student (with verification)
$120. USA (Institutional)
$130. Outside USA (Institutional)
Back issues upon request.
Email: orders@brit.org
www.britpress.org
shop.brit.org

Composition

rhorngraphics, Plano, Texas; rlrchorn@verizon.net

Printing

Prepress production and printing in the United States of America by Millet the Printer, Dallas, Texas
www.millettheprinter.com

Cover Illustration

Electronically tinted botanical illustration of *Liatris aestivalis* originally used on BRIT's anniversary poster 2001. Summer gayfeather flowers mid Jul–Aug(–Sep) and is endemic to Oklahoma and Texas.
Sida 19:768. 2001.
Botanical illustration by Linny Heagy ©2001.

BRIT®
PRESS

Table of Contents

SYSTEMATICS

Recent findings on the gypsum flora of the rim of the Guadalupe Mountains, New Mexico, U.S.A.: A new species of **Nerisyrenia** (Brassicaceae), a new state record, and an updated checklist
Patrick J. Alexander, Norman A. Douglas, Helga Ochoterena, Hilda Flores-Olvera, and Michael J. Moore **383**

Lomatium swingerae: a new species of **Lomatium** (Umbelliferae) from the Joseph Plains, Idaho, U.S.A.
Richard P. McNeill **395**

New geographical and morphological data for **Sideroxylon reclinatum** subspecies **austrofloridense** (Sapotaceae), a taxon endemic to southeastern peninsular Florida, U.S.A.
Paul T. Corogin and Walter S. Judd **403**

A morphologically based taxonomic reevaluation of the genus **Stipulicida** (Caryophyllaceae), with comments on rank
Derick B. Poindexter, Kateland E. Bennett, and Alan S. Weakley **419**

A new hedge-nettle (**Stachys:** Lamiaceae) from South Carolina, U.S.A.
John B. Nelson and Douglas A. Rayner **431**

Agave × madrensis (Asparagaceae), a putative hybrid from the Sierra Madre Oriental, Mexico
José A. Villarreal Quintanilla, Abraham Ramírez Gámez, Eduardo Estrada Castillón, Dino U. González Uribe, and Diana Jasso de Rodríguez **441**

Dos nuevas especies de **Myrcia** (Myrtaceae), del Pacífico sur de Costa Rica
Daniel Santamaria Aguilar, Armando Estrada Ch. y Reinaldo Aguilar **449**

Taxonomic studies in the Miconieae (Melastomataceae). XII. Revision of **Miconia** sect. **Miconiastrum,** with emphasis on the **Miconia bicolor** complex
Walter S. Judd, James Dan Skean, Jr., Eldis R. Bécquer, and Lucas C. Majure **457**

Calathea rubribracteata, a new endemic species of Marantaceae from Colombia
Helen Kennedy **493**

Five new Myrtaceae from southeastern Brazil
Marcos Sobral, Marcelo da Costa Souza, Ludovic Jean Charles Kollmann, Osny Tadeu Aguiar, André Luís Casarin Rochelle, and Kelly Antunes **497**

Browneopsis puyensis (Leguminosae: Caesalpinioideae: Detarieae), a new species from Amazonian Ecuador
David A. Neill and Mercedes Asanza **511**

A new species of **Garnotia** (Poaceae) from Kerala, India
C.N. Sunil, V.V. Naveen Kumar, and M.G. Sanilkumar **517**

Tripogon malabarica (Poaceae: Chloridoideae: Chlorideae: Tripogoninae), a new species from Kerala, India
Thoiba Kottekkattu and A.K. Pradeep **523**

Wandersong (Rubiaceae), a new genus from the Greater Antilles
David W. Taylor **529**

DEVELOPMENT AND STRUCTURE

Variability of vegetative flush colors in **Zamia** (Cycadales)
Claudia Calonje, Lindy Knowles, Michael Calonje, and Chad Husby **531**

Limitations to natural production of **Lophophora williamsii** (Cactaceae) III. Effects of repeated harvesting at two-year intervals for six years in a South Texas (U.S.A.) population
Martin Terry, Keeper Trout, Bennie Williams, Teodoso Herrera, and Norma Fowler **541**

PALEOBOTANY

Distigouania irregularis (Rhamnaceae) gen. et sp. nov. in Mid-Tertiary amber from the Dominican Republic
Kenton L. Chambers and George O. Poinar, Jr. **551**

Ticodendron palaios sp. nov. (Ticodendraceae), a Mid-Tertiary fossil flower in Dominican amber
Kenton L. Chambers and George O. Poinar, Jr. **559**

FLORISTICS, ECOLOGY, AND CONSERVATION

Vegetation patterns in the Mediterranean-desert ecotone of Baja California, Mexico
Sula Elizabeth Vanderplank, Jose Delgadillo, Exequiel Ezcurra, and Lucinda A. McDade **565**

Estructura de un zacatal de toboso (**Hilaria mutica:** Poaceae) asociado a sustrato ígneo en el noreste de Coahuila, México
Juan A. Encina-Domínguez, Jesús Valdés-Reyna y José A. Villarreal-Quintanilla **583**

Jarilla chocola (Caricaceae), un nuevo género y especie para la flora de El Salvador
Frank Sullyvan Cardoza Ruiz, José Ledis Linares y Ana Eugenia Aguilar Grijalva **595**

Redescubrimiento y nuevos registros de **Cuscatlania vulcanicola** (Nyctaginaceae) para El Salvador
José Ledis Linares, Frank Sullyvan Cardoza Ruiz y Patricia Hernández-Ledesma **603**

Vascular plant flora of the alpine zone in the Southern Rocky Mountains, U.S.A.
James F. Fowler, B.E. Nelson, and Ronald L. Hartman **611**

The first naturalized occurrence of the Cannaceae family in the Arkansas (U.S.A.) flora, with additional new and noteworthy angiosperm records for the state
Brett E. Serviss, James H. Peck, and Tiffany A. Graves **637**

American mistletoe (**Phoradendron leucarpum** ssp. **leucarpum,** Viscaceae) occurrence in host trees within the city of Cairo, Alexander County, Illinois, and its incidence in Illinois, U.S.A.
Ralph L. Thompson **641**

Tetragonia tetragonioides (Aizoaceae) discovered in Louisiana, U.S.A.
Sairah M. Javed and Lowell E. Urbatsch **661**

Amsonia ludoviciana (Apocynaceae) new to the flora of Texas, U.S.A.
Chris Doffitt, Charles Allen, Patricia Lewis, and David Lewis **663**

The vascular flora and plant communities of Candy Abshier Wildlife Management Area, Chambers County, Texas, U.S.A.
Jason R. Singhurst, Amos Cooper, David J. Rosen, and Walter C. Holmes **665**

In Memoriam

Landon E. McKinney (1949–2014)
Ronald L. Jones and Ralph L. Thompson **677**

Book Reviews, Notices, and Announcements 394, 402, 418, 448, 456, 492, 522, 528, 558, 582, 602, 610, 640, 676

Reviewers for Volume 8 (2014)—**679**
Index to Volume 8 (2014)—**680**
Titles of Articles with Authors—**680**
Authors—**682**
Botanical Names and Subjects—**683**
New Names and Combinations—**685**

INDEX to new names and new combinations in *J. Bot. Res. Inst. Texas 8(2), 2014*

Agave × madrensis Villarreal, A. Ramírez, & A.E. Estrada, hybrid nov.—**443**
Browneopsis puyensis D.A. Neill & Asanza, sp. nov.—**511**
Calathea rubribracteata H. Kenn., sp. nov.—**493**
Calyptranthes solitaria Sobral, Aguiar, & Antunes, sp. nov.—**498**
Calyptranthes ubatubana Sobral & Rochelle, sp. nov.—**500**
Distigouania K.L. Chambers & Poinar, gen. nov.—**552**
Distigouania irregularis K.L. Chambers & Poinar, sp. nov.—**552**
Eugenia dipetala Sobral & Kollmann, sp. nov.—**502**
Garnotia variyamensis Sunil, Naveen Kumar, & Sanilkumar, sp. nov.—**517**
Lomatium swingerae R.P. McNeill, sp. nov.—**395**
Miconia barbata (Borhidi) Judd, Bécquer, & Majure, comb. nov.—**478**
Miconia bicolor var. **patenti-setosa** (Borhidi) Judd, Bécquer, & Majure, comb. nov.—**474**
Miconia cajalbanensis Judd, Bécquer, & Majure, nom. nov.—**483**
Miconia cristalensis (Borhidi) Judd, Bécquer, & Majure, comb. nov.—**485**
Miconia guajaibonensis Judd, Bécquer, & Majure, nom. nov.—**474**
Miconia impressa (Urb.) Judd, Bécquer, & Majure, comb. nov.—**476**
Miconia karsticola Judd, Bécquer, Skean, & Majure, nom. nov.—**463**
Miconia maestrensis Judd, Bécquer, & Majure, nom. nov.—**487**
Miconia sect. **Miconiastrum** (Bonpl. ex Naudin) Judd, Bécquer, & Majure, comb. nov.—**461**
Myrcia cacuminis Kollmann & Sobral, sp. nov.—**504**
Myrcia paulii-jonesii Aguilar, D. Santam., & A. Estrada, sp. nov.—**449**
Myrcia riverae A. Estrada, D. Santam., & Aguilar, sp. nov.—**452**
Nerisyrenia hypercorax P.J. Alexander & M.J. Moore, sp. nov.—**384**
Plinia ambivalens M. Souza & Sobral, sp. nov.—**507**
Stachys caroliniana J.B. Nelson & D.A. Rayner, sp. nov.—**431**
Stipulicida lacerata (C.W. James) D.B. Poind., K.E. Bennett, & Weakley, comb. et stat. nov.—**426**
Ticodendron palaios K.L. Chambers & Poinar, sp. nov.—**560**
Tripogon malabarica Thoiba & Pradeep, sp. nov.—**523**
Wandersong D.W. Taylor, gen. nov.—**530**
Wandersong exserta (DC.) D.W. Taylor, comb. nov.—**530**
Wandersong seminervis (Urb. & Ekman) D.W. Taylor, comb. nov.—**530**

RECENT FINDINGS ON THE GYPSUM FLORA OF THE RIM OF THE GUADALUPE MOUNTAINS, NEW MEXICO, U.S.A.: A NEW SPECIES OF *NERISYRENIA* (BRASSICACEAE), A NEW STATE RECORD, AND AN UPDATED CHECKLIST

Patrick J. Alexander
Department of Biology, MSC 3AF
New Mexico State University
Las Cruces, New Mexico 88003, U.S.A.
paalexan@polyploid.net

Norman A. Douglas
Department of Biology
Oberlin College
Oberlin, Ohio 44074, U.S.A.
ndouglas@oberlin.edu

Helga Ochoterena
Departamento de Botánica
Instituto de Biología
Universidad Nacional Autónoma de México
Apartado Postal 70-367
Mexico, D.F. 04510, MEXICO
helga@ib.unam.mx

Hilda Flores-Olvera
Departamento de Botánica
Instituto de Biología
Universidad Nacional Autónoma de México
Apartado Postal 70-367, Mexico, D.F. 04510, MEXICO
mahilda@ib.unam.mx

Michael J. Moore
Department of Biology
Oberlin College
Oberlin, Ohio 44074, U.S.A.
mmoore@oberlin.edu

ABSTRACT

Exposures of Yeso Formation gypsum along the western escarpment (The Rim) of the Guadalupe Mountains in southeastern New Mexico were first explored botanically in 1996, which revealed the existence of two gypsophilic taxa, *Anulocaulis leiosolenus* var. *howardii* and *Mentzelia humilis* var. *guadalupensis*, both of which are only known from that area. Fieldwork by the authors has revealed another gypsophile restricted to The Rim, **Nerisyrenia hypercorax,** which is here described. The new species is similar to *N. gypsophila* and *N. mexicana*, from which it differs in having shorter, crispate fruits and smaller floral parts. We also report a new state record of *Paronychia wilkinsonii* in New Mexico and make additional observations regarding the gypsum flora of The Rim.

RESUMEN

Las exposiciones de yeso de la "Formación Yeso" en la escarpa occidental de las Montañas de Guadalupe, conocida como "The Rim," en el sureste de Nuevo México fueron inicialmente exploradas botánicamente en 1996, cuando se descubrió la existencia de dos taxones gipsófilos, *Anulocaulis leiosolenus* var. *howardii* y *Mentzelia humilis* var. *guadalupensis*, conocidos solamente de esa área. El trabajo de campo realizado recientemente por los autores, permitió descubrir otra planta gipsófila endémica restringida a dicha formación y localidad, **Nerisyrenia hypercorax,** que se describe aquí. La nueva especie es similar a *N. gypsophila* y *N. mexicana* pero difiere de ellas en los frutos más cortos, crispados y las partes florales más pequeñas. También registramos *Paronychia wilkinsonii* por primera vez para Nuevo México y proporcionamos observaciones adicionales sobre la flora de la región.

INTRODUCTION

Gypsum exposures are distributed in an island-like fashion throughout the Chihuahuan Desert region and host a diverse array of over 200 gypsophilic (i.e. occurring only on gypsum) plant species in over 35 families (Powell & Turner 1977; Moore & Jansen 2007). In the US portion of the Chihuahuan Desert, gypsum deposits are common in much of central and southern New Mexico and adjacent west Texas (Weber & Kottlowski 1959; Anderson & Dean 1995) and host a number of gypsophilic taxa that vary in distribution across the region. The dominant gypsophilic taxa in New Mexico and Texas typically include *Sporobolus nealleyi* (Poaceae), *Tiquilia hispidissima* (Boraginaceae), *Dicranocarpus parviflorus* (Asteraceae), *Sartwellia flaveriae* (Asteraceae), *Oenothera hartwegii* subsp. *filifolia* (Onagraceae), *Nerisyrenia linearifolia* (Brassicaceae), and *Acleisanthes lanceolata* (Nyctaginaceae). In addition, a number of narrowly distributed gypsophiles are found in New Mexico and west Texas. In northern New Mexico, for example, exposures of Todilto Formation gypsum are

home to the narrow endemics *Abronia bigelovii* Heimerl (Nyctaginaceae), *Mentzelia todiltoensis* N.D. Atwood & S.L. Welsh (Loasaceae), *Townsendia gypsophila* Lowrey & P.J. Knight (Asteraceae), and *Phacelia sivinskii* N.D. Atwood, P.J. Knight & Lowrey (Boraginaceae).

In southern New Mexico and adjacent west Texas a number of locally endemic gypsophiles can be found near the Guadalupe Mountains (New Mexico Rare Plant Technical Council 1999–2012). Although the mountain range itself is composed primarily of Permian limestone, gypsum is present on both the western and eastern sides of the Guadalupe Mountains as part of the Castile, Seven Rivers, and Yeso formations, and as Quaternary lacustrine deposits that are ultimately derived from the Yeso and Castile formations (Boyd 1958; King 1948; Scholle 2003). Four narrowly endemic gypsophiles are known only from the eastern side of the Guadalupe Mountains. Two of these species are found only on the Castile Formation [*Astragalus gypsodes* Barneby (Fabaceae) and *Linum allredii* Sivinski & M.O. Howard (Linaceae)], whereas the other two are found on both the Castile and Seven Rivers formations [*Amsonia tharpii* Woodson (Apocynaceae) and *Eriogonum gypsophilum* Wooton & Standl. (Polygonaceae)]. The narrowly endemic *Lepidospartum burgessii* B.L. Turner (Asteraceae) is known only from the southwestern side of the Guadalupe Mountains, on the east side of Crow Flats and Salt Basin in Quaternary lacustrine gypsum deposits. The western escarpment of the Guadalupe Mountains, known as The Rim, is composed mostly of San Andres Formation limestone, but gypsum of the Yeso Formation outcrops frequently near the base of The Rim, occasionally forming extensive exposures such as those near the mouth of Pup Canyon (Figs. 1, 2). These gypsum outcrops were unexplored by botanists prior to 1996–97, when the Pup Canyon gypsum was first systematically collected by M. Howard, R. Spellenberg, and T. Wootten (Spellenberg & Wootten 1999). These explorations led to the discovery and description of two gypsophiles, *Anulocaulis leiosolenus* var. *howardii* (Nyctaginaceae) and *Mentzelia humilis* var. *guadalupensis* (Loasaceae).

The gypsum at the base of The Rim is remote, and much of it is difficult to access; consequently, the flora of this area remains relatively poorly known. In August and September 2013 the authors visited the gypsum exposures along The Rim of the Guadalupe Mountains in support of an ongoing project to understand the evolutionary history of the Chihuahuan Desert gypsophilic flora. This fieldwork revealed the existence of a new gypsophilic taxon that appears to be restricted to The Rim, *Nerisyrenia hypercorax*, which is here described. We also report new floristic observations for this region, including a state record of the rare *Paronychia wilkinsonii* S. Watson and an updated checklist of plants currently known from the gypsum of The Rim (Appendix 1).

A NEW SPECIES OF *NERISYRENIA*

Nerisyrenia Greene is a small genus, including 7 (Rollins 1993), 8 (Al-Shehbaz 2012), 9 (Bacon 1978), or 11 (Turner 1993) species. The most recent monograph of the genus is that of Bacon (1978). Nomenclature of *Nerisyrenia* and characteristics of previously-published species below are based on this work and the subsequent paper by Turner (1993). *Nerisyrenia* is restricted to the Chihuahuan Desert region and has a remarkable affinity for gypsum. All the species are gypsophiles except the widespread and variable *Nerisyrenia camporum* (A. Gray) Greene. These gypsophilic taxa are largely allopatric with respect to one another, and collectively they occupy gypsum exposures from central New Mexico to northern San Luis Potosí (Bacon 1978). In the United States, only two taxa were previously known: *N. camporum* and *N. linearifolia*. The discovery of *N. hypercorax* adds yet another gypsophilic species to the genus and to the flora of New Mexico. The visit to Pup Canyon by the authors on 20 Aug 2013 coincided with the filming of Episode 5 of the educational video series Plants Are Cool Too!, which can be viewed at http://www.youtube.com/watch?v=a16mBFTkrks.

Nerisyrenia hypercorax P.J. Alexander & M.J. Moore, sp. nov. (**Figs. 3, 4**) TYPE: U.S.A. NEW MEXICO. Otero Co.: W-facing gypsum slopes of The Rim of the Guadalupe Mountains, just N of Pup Canyon, 32.37803°N, 105.07308°W, 1339 m; scattered in diverse gypsophilic community on relatively barren gypsum, with no single dominant species; subshrubs to 25 cm tall, petals white, not senescing lavender, leaves somewhat succulent, never linear, 20 Aug 2013 (fl, fr), *M.J. Moore et al. 2272* (HOLOTYPE: NMC; ISOTYPES: MEXU, OC, TEX/LL, UNM).

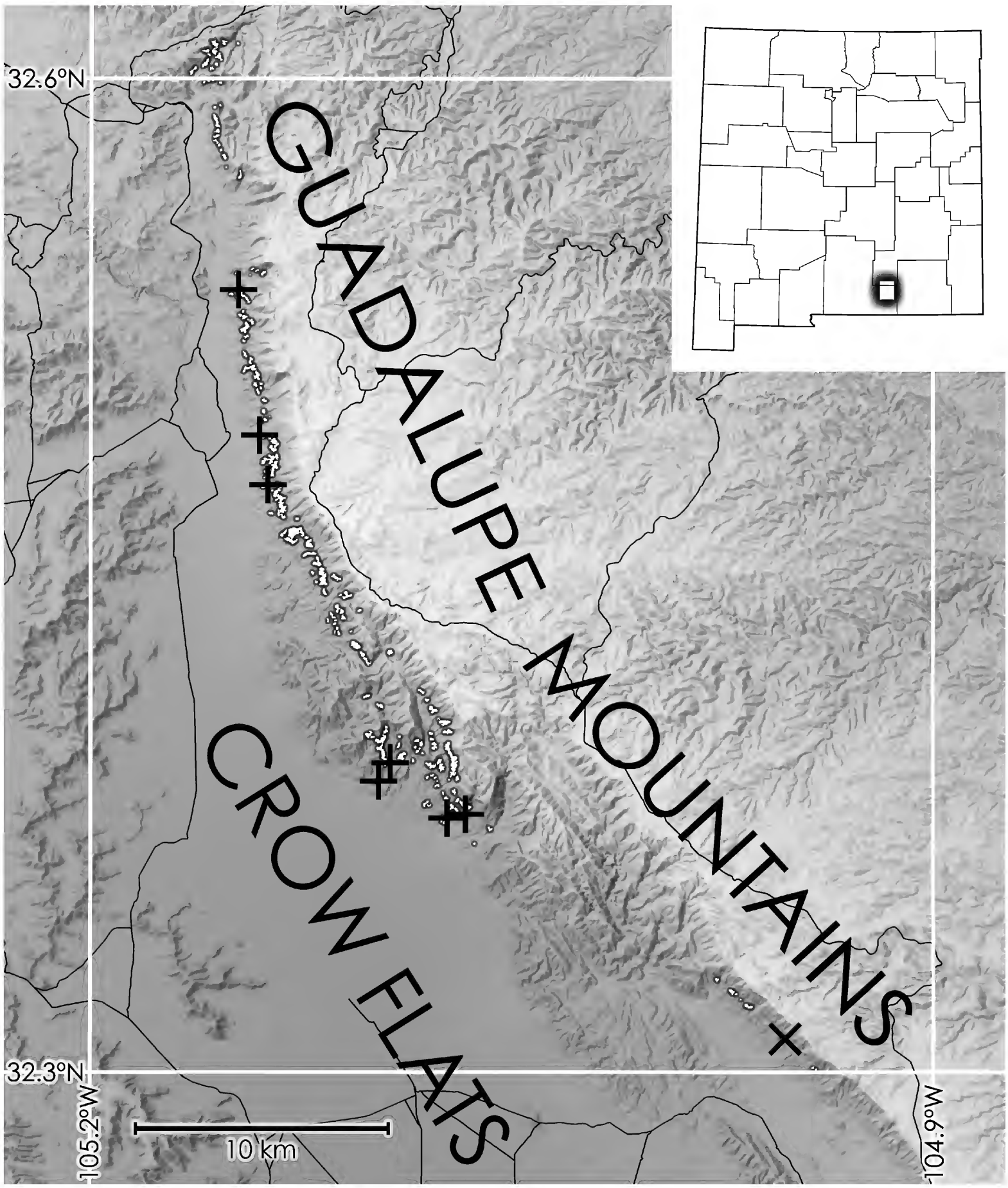


Fig. 1. Known distribution of *N. hypercorax* ("+"), closest known population of *N. linearifolia* ("×"), and approximate distribution of Yeso Formation gypsum outcrops along the Guadalupe Mountains rim (shown in white with dark outline).

Similar to *N. gypsophila* J.D. Bacon and *N. mexicana* (J.D. Bacon) B.L. Turner but differing in having shorter (usually 5–12 mm, vs. > 15 mm), crispate, incurved fruits and smaller floral parts; crispate fruits are apparently unique in the genus.

Suffrutescent perennials or subshrubs, not rhizomatous; individuals more or less hemispherical, 1–2.5 (–3.5) dm tall. Moderately pubescent throughout, trichomes mostly appressed, sessile or short-stalked (stalks to 0.05 mm), predominately dendritically 5-branched (rays to 0.25 mm), some trichomes 3-rayed to dendritically

Fig. 2. Habitat of *N. hypercorax*: **A.** at the type locality; **B.** at the site of *Alexander 1330*.

7-branched. **Stems** branched throughout, 3–6 from a branched, woody caudex, older woody stems to 1 cm in diameter, herbaceous stems to 1 mm diameter. **Cauline leaves** succulent, strongly overlapping, 3–6 times longer than wide, the larger (18–)22–40(–48) mm long, (4–)6–12(–14) mm wide, oblanceolate to spatulate, attenuate at the base and obtuse to acute at the apex, margins entire to weakly sinuate or, rarely, obscurely sinuate-dentate. **Flowers** with sepals (3.0–)4.0–6.0 mm long, 1.0–1.5 mm wide, broadly lanceolate in outline. Petals white, not fading purple on senescence, (rarely fading very pale lavender), 7–9 mm long, 3.5–4.5 mm wide, obovate to spatulate in outline, blade margins entire, dilate and denticulate at base. Stamens weakly tetradynamous, 2.5–5.5 mm long, anthers medifixed, straight and 1.5–1.8 mm long at anthesis, curling with

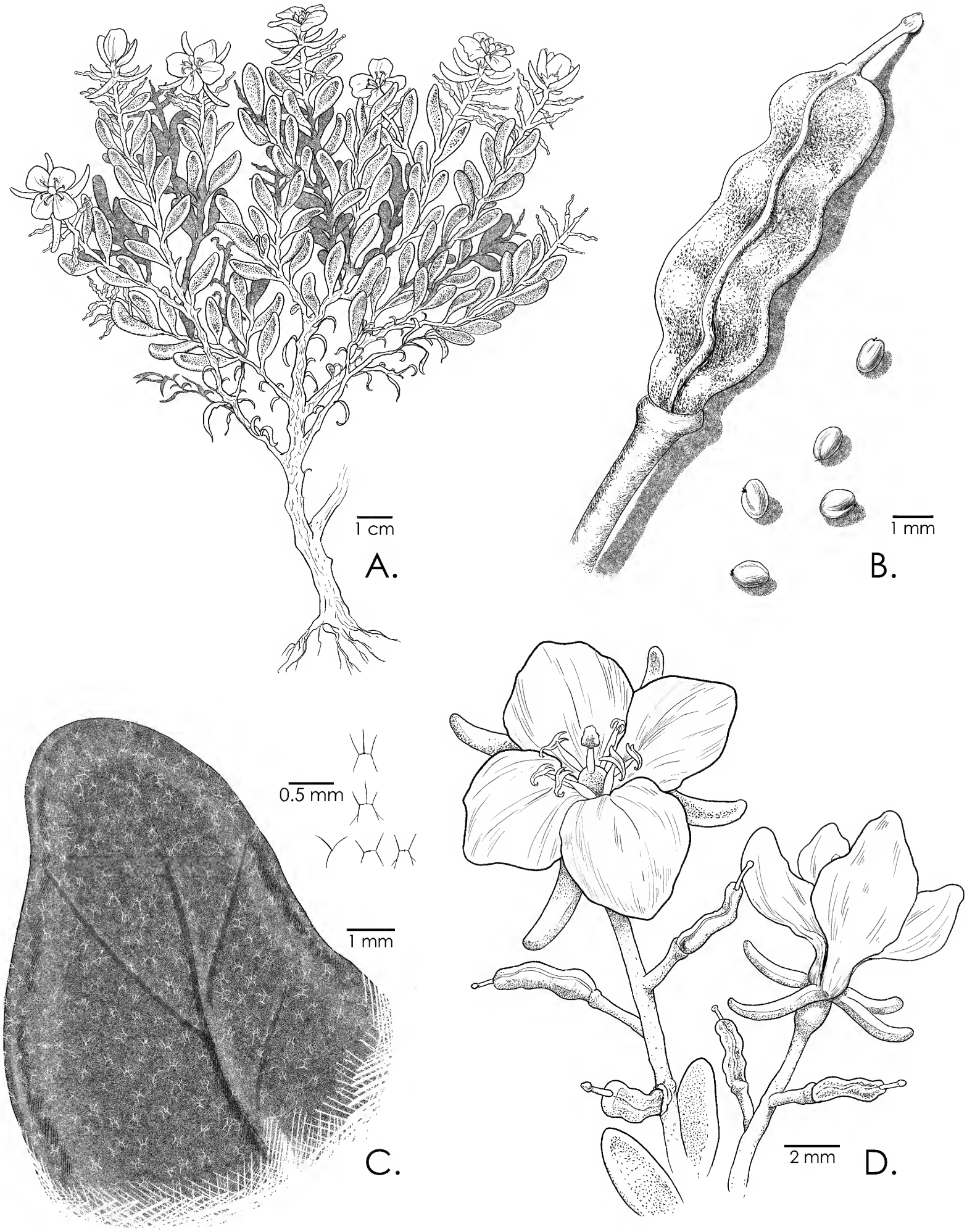


Fig. 3. Line drawing of *N. hypercorax*, based on *P.J. Alexander 1324* and *M.J. Moore et al. 2272*. **A.** Plant habit. **B.** Mature fruit and seeds. **C.** Apex of a cauline leaf and enlarged view of leaf trichome forms. **D.** Flowers and immature fruit. Illustration by Avery Liell-Kok.

Fig. 4. *Nerisyrenia hypercorax*. **A.** Flower at the type locality. **B.** Fruit at the site of *P.J. Alexander 1324*. **C.** Plant habit at the type locality.

age, filaments 2.0–4.5 mm long. Ovary tomentose, 2–4 mm long, 0.8–1.5 mm wide, style glabrous, 1.3–2.2 mm long, stigma deltoid-sagittate, 0.5–0.8 mm long, somewhat decurrent on the style. **Infructescences** compact, (1.5–)2.0–4.5(–6.5) cm long, with 5–15(–20) fruits, middle internodes 1–5 mm long, pedicels straight, ascending to, infrequently divaricate, (3–)4–9(–13) mm long. **Siliques** obcompressed (angustiseptate), oblong, rounded-

truncate at apex, not tapered to style, incurved, crispate (tortuose), 5–12(–16) mm long, 2.2–3.0 mm wide, inner surfaces of the valves glabrous; replum 0.8–1 mm wide. Ovules 20–40 per silique, seeds broadly elliptic to broadly ovate, 0.8–1 mm long, 0.6–0.7 mm wide, somewhat flattened, about half as thick as wide, yellow-orange.

Etymology.—The specific epithet refers to the distribution of the species, above Crow Flats.

Phenology.—Flowering specimens have been collected from late July to early September, while specimens with mature fruits have been collected in August and early September.

Geography and habitat.—*Nerisyrenia hypercorax* occurs on gypsum of the Yeso Formation on the west side of the Guadalupe Mountains, at the mouth of Pup Canyon and north-northwest for ca. 20 km, between 1300 and 1600 m. *Nerisyrenia hypercorax* has been found at every site within this band that has been visited by botanists.

Distinction from other Nerisyrenia.—In the treatment by Bacon (1978), *N. hypercorax* keys to *Nerisyrenia gypsophila* J.D. Bacon, a gypsophile found throughout east central Chihuahua. However, it is perhaps morphologically closer to *Nerisyrenia mexicana* (J.D. Bacon) B.L. Turner, a gypsophile of southeastern Coahuila, southern Nuevo León, and adjacent San Luis Potosí and Tamaulipas, which has similarly short pedicels and styles. Nevertheless, *N. hypercorax* differs from these two species by its shorter fruits and smaller floral parts. For example, it is distinguished from both species by its shorter siliques (5–125–12 mm vs. 17–30 for *N. gypsophila* and 15–27 for *N. mexicana*), shorter anthers (1.5–1.8 mm vs. 2.4–3.4 and 2.5–3.5, respectively), smaller petals (7–9 mm long, 3.5–4.5 mm wide, vs. 9.5–11.5 × 4.5–8.5 in *N. gypsophila*, and 8.5–13 × 5.0–8.5 in *N. mexicana*), usually shorter filaments (2.5–4.5 mm vs. 4–6 in both *N. gypsophila* and *N. mexicana*), and usually shorter infructescences (2–4.5 cm vs. 4–30 and 6–19, respectively). From *N. gypsophila* it is further distinguished by its shorter sepals (4–6 mm vs. 6.5–8.5), usually shorter pedicels (5–9 mm vs. 8–12), shorter styles (1.3–2.2 mm vs. 2.7–4.0), and incurved rather than straight siliques. The crispate fruits of *N. hypercorax*, present in all individuals observed, are apparently unique in the genus and most readily distinguish this species from other *Nerisyrenia*.

Previously, only two species of *Nerisyrenia* were known from New Mexico: the gypsophilic *N. linearifolia* and the morphologically and edaphically variable *N. camporum*. *Nerisyrenia linearifolia* is found on gypsum throughout the southern two-thirds of the state and in adjacent western Texas, while *N. camporum* is the most widespread species in the genus, common along the Rio Grande Valley and the southern third of the New Mexico as well as in southwestern Texas and the Mexican states of Chihuahua, Coahuila, Durango, Nuevo León, Tamaulipas, and Zacatecas. While *N. hypercorax* shares the broader leaves of *N. camporum*, it differs from this species in a number of respects, principally in its more suffruticose habit (vs. herbaceous to weakly suffrutescent perennial), entire leaf margins (vs. typically dentate leaves), relatively compact inflorescences that only slightly exceed the leaves (vs. elongate inflorescences that greatly exceed the leaves), and its petals, which do not turn pale lavender or purple upon senescence as in *N. camporum*. Indeed, *N. hypercorax* shares all of these character states with its gypsum-loving cousin *N. linearifolia*, although the broad, shorter leaves, generally smaller flower parts, and shorter, crispate fruits of the former serve to easily distinguish it from the latter. A key to *Nerisyrenia* in New Mexico is provided below.

KEY TO THE *NERISYRENIA* SPECIES OF NEW MEXICO

1. Leaves linear, all less than 5 mm wide _____ **N. linearifolia**
1. Leaves oblanceolate, spatulate, or obovate, the larger more than 5 mm wide
   2. Fruits crispate, less than 15 mm long; infructescences less than 7 cm long; petals less than 5 mm wide, remaining white _____ **N. hypercorax**
   2. Fruits not crispate, more than 15 mm long; infructescences more than 7 cm long; petals more than 5 mm wide, fading lavender _____ **N. camporum**

Although *N. camporum* and *N. linearifolia* can be found growing together in New Mexico, so far as is known neither species co-occurs with *N. hypercorax*. The authors have found *N. hypercorax* at five sites but did not observe any other *Nerisyrenia* at these sites. There are only two previous *Nerisyrenia* specimens from this band of gypsum in regional herbaria, both *N. hypercorax*.

Paratypes.—**U.S.A. New Mexico. Chaves Co.:** Lincoln National Forest, W slope of the Guadalupe Mountains ca. 1.5 mi N of Otero county line, 32.53752°N 105.14758°W, elev. 1579 m, limestone interbedded with gypsum, 23 Jul 2012 (fl), *K.D. Heil 34399* (SJNM). **Otero Co.:** W base of the Guadalupe Mountains E of Piñon Creek, 1.9 mi S of the Chaves County line, 1.7 mi NE of Tanner Ranch, 32.4936°N 105.1399°W (WGS84), elev. 1540 m, along small incised ravines in a SW-facing, reddish gypsum outcrop, 2 Sep 2013 (fl, fr), *P.J. Alexander 1324* (DUKE, MEXU, MO, NMC, OC); W base of the Guadalupe Mountains E of Piñon Creek, 2.9 mi S of the Chaves County line, 1.2 mi ENE of Tanner Ranch, 32.4786°N 105.1369°W (WGS84), elev. 1550 m, along a narrow arroyo deeply incised in gypsum, 1 Sep 2013 (fl, fr), *P.J. Alexander 1330* (DUKE, MEXU, MO, NMC, OC); 49 km NNE of Dell City, Texas, W base of Guadalupe Mts., N of mouth of Pup Canyon, 32.37917°N 105.06650°W, elev. 1460 m, gypseous slopes on upper bajada, W-facing, 5 Aug 1997 (fr), *R.W. Spellenberg 12442* (NMC); west base of the Guadalupe Mountains, 2.0 mi E of Johnson Tanks and 2.6 mi WNW of the mouth of Pup Canyon, 32.38921°N 105.09743°W (WGS84), elev. 1330 m, small outcrop of gypseous clay near the mouth of a small limestone canyon, 28 Aug 2014 (fl, fr), *P.J. Alexander & M.O. Howard 1463* (MO, NMC, OC); west base of the Guadalupe Mountains, 2.2 mi E of Johnson Tanks and 2.6 mi NW of the mouth of Pup Canyon, 32.39478°N 105.09323°W (WGS84), elev. 1360 m, gypseous clay cutbanks in a small limestone canyon, immediately below large expanses of open gypsum, 28 Aug 2014 (fl, fr), *P.J. Alexander & M.O. Howard 1464* (NMC, OC, UNM).

FLORA OF THE YESO FORMATION GYPSUM ALONG THE RIM

Spellenberg and Wootten (1999) compiled a list of 59 vascular plant taxa occurring on Yeso Formation gypsum at The Rim from their fieldwork on the north side of Pup Canyon and a site northeast of Tanner Ranch. Fieldwork by the authors and additional visits to the area by K. Heil and associates at San Juan College and R. Worthington of the University of Texas at El Paso have increased our knowledge of the gypsum flora of The Rim from Pup Canyon and to the north-northwest for ca. 20 km. This expanded list includes 74 vascular plant taxa in 27 plant families and is provided in Appendix 1. The endemics *Mentzelia humilis* var. *guadalupensis* and *Nerisyrenia hypercorax* are found throughout this band of gypsum, while *Anulocaulis leiosolenus* var. *howardii* has been found only on gypsum in the immediate vicinity of Pup Canyon.

There are several additional small outcrops of Yeso Formation gypsum southeast of Pup Canyon on the east side of Big Dog Canyon that have not previously been botanically explored. The first author visited one of these sites in September 2013 to determine if *N. hypercorax* is present. None of the narrow endemics of The Rim were found at this site. Instead of *N. hypercorax* and *M. humilis* var. *guadalupensis*, the more widespread *N. linearifolia* and *M. humilis* var. *humilis* were found at Big Dog Canyon, while no *Anulocaulis* was seen. A list of 37 vascular plant taxa in 20 families observed at the site is provided in Appendix 2.

PARONYCHIA WILKINSONII, A NEW STATE RECORD

On limestone adjacent to Yeso Formation gypsum, the first author found *Paronychia wilkinsonii*, here first reported from New Mexico: U.S.A. New Mexico. Otero Co.: west base of the Guadalupe Mountains east of Piñon Creek, 2.9 miles south of the Chaves County line, 0.9 miles east-northeast of Tanner Ranch, 32.4786°N 105.1421°W (WGS84), elev. 1490 m, gentle west slope, limestone cobble, 2 Sep 2013 (fl, fr), *P.J. Alexander 1329* (NMC, OC, RM). This is a rare species previously known only from outcrops of novaculite (a form of chert comprised primarily of microcrystalline quartz) in the Marathon Basin of western Texas and a few scattered sites in the Mexican states of Chihuahua and Coahuila (Poole et al. 2007). This population in New Mexico is ca. 300 km disjunct from the nearest known populations near Marathon.

DISCUSSION

The presence of at least three locally endemic gypsophiles at Pup Canyon and neighboring gypsum sites along The Rim implies that little gene flow has occurred between gypsum at The Rim and other gypsum exposures, allowing allopatric speciation, and it further raises the possibility that conditions supporting the long-term persistence of gypsophiles may have characterized The Rim for all or much of the Pleistocene. During full-glacial periods of the Pleistocene, New Mexico experienced a significantly cooler and wetter climate, resulting in the replacement of "typical" Chihuahuan Desert vegetation with grassland and savanna that is similar to that seen in central New Mexico today (Van Devender 1990, Elias & Van Devender 1992). The southerly location of The Rim in New Mexico, its relatively low elevation, and its west-facing aspect may have resulted in a warmer, drier microclimate during full-glacial periods, helping to maintain the semi-arid character of the site

over time. Even today the gypsum exposures along The Rim are relatively thinly vegetated compared to most other gypsum deposits in the Chihuahuan Desert (Fig. 2), which likely results in part from this warmer, drier microclimate. Moreover, the gypsum substrate itself may have helped promote community stability for gypsophilic taxa during the wetter periods of the Pleistocene by reducing or preventing the growth of non-gypsophilic plant taxa, which often have great difficulty establishing and persisting on gypsum (Damschen et al. 2012; Escudero et al. 2014; Moore et al. 2014). Ongoing phylogenetic and phylogeographic studies of the Chihuahuan Desert gypsum flora in the lab of Michael Moore at Oberlin College will help to test this hypothesis and will shed light on the evolutionary relationships of the unique gypsum flora at Pup Canyon.

APPENDIX 1

The following list includes all species known to occur on gypsum of The Rim from Pup Canyon northward. All species listed by Spellenberg and Wootten (1999) are included. The list is supplemented by observations made by the authors and specimens collected by R. Worthington, K. Heil, S. O'Kane, D. Schleser, and L. Urban. Species are followed by all known herbarium specimens and deposition of specimens is indicated by herbarium codes following Index Herbariorum (Thiers 1997–2013). If no specimens are listed, the species has been observed in the field, either by Spellenberg and Wootten (1999) or by the present authors, but no voucher has been collected. Unfortunately, the remoteness of the area and logistic constraints has prevented complete collection of the gypsum flora of The Rim. We have opted to provide as complete an account as possible, despite lack of vouchers for some species. Nomenclature below the rank of family follows Allred and Ivey (2012), families follow APG III (2009), and most herbarium specimen data are available online (SEINet 2009–2013).

Amaranthaceae: *Atriplex canescens* (Pursh) Nutt.; *Tidestromia suffruticosa* (Torr.) Standl. var. *suffruticosa*: *Spellenberg & Wootten 12481* (NMC), *Moore et al. 2278* (OC, NMC, TEX/LL, MEXU).

Anacardiaceae: *Rhus microphylla* Engelm.

Apocynaceae: *Amsonia longiflora* Torr. var. *salpignatha* (Woodson) McLaughlin: *Spellenberg et al.12434* (NMC, NY, UNM), *Spellenberg et al. 12441* (NMC, NY), *Spellenberg & Wootten 12474* (NMC, NY), *Spellenberg & Wootten 12501* (NMC, NY); *Asclepias macrotis* Torr.: *Spellenberg & Wootten 12507* (NMC, NY), *Heil 34405* (SJNM).

Asparagaceae: *Dasylirion leiophyllum* Engelm. ex Trel.; *Nolina texana* S. Watson: *Heil 34400* (SJNM); *Yucca elata* (Engelm.) Engelm.; *Yucca treculeana* Carrière.

Asteraceae: *Artemisia ludoviciana* Nutt.; *Brickellia laciniata* A. Gray; *Gaillardia multiceps* Greene; *Gutierrezia microcephala* (DC.) A. Gray; *Haploësthes greggii* A. Gray var. *texana* (J.M. Coult.) I.M. Johnst.: *Spellenberg et al. 12437* (NMC), *Heil 34397* (SJNM), Moore *et al. 2274* (OC, NMC, TEX/LL, MEXU); *Parthenium incanum* Kunth: *Heil 34394* (SJNM); *Porophyllum scoparium* A. Gray: *Spellenberg et al. 12436* (NMC, UC), *Worthington 30289* (UNM, UTEP); *Sartwellia flaveriae* A. Gray: *Worthington 30282* (UNM, UTEP); *Sidneya tenuifolia* (A. Gray) E.E. Schill. & Panero; *Thelesperma megapotamicum* (Spreng.) Kuntze: *Moore et al. 2279* (OC, NMC, TEX/LL, MEXU); *Thymophylla acerosa* (DC.) Strother: *Spellenberg & Wootten 12484* (NMC); *Thymophylla pentachaeta* (DC.) Small var. *belendinium* (DC.) Strother: *Spellenberg & Wootten 12475* (NMC, NY), *Spellenberg & Wootten 12483* (BRIT); *Xanthisma spinulosum* (Pursh) D.R. Morgan & R.L. Hartm. var. *chihuahuanum* (B.L. Turner & R.L. Hartm.) D.R. Morgan & R.L. Hartm.: *Spellenberg & Wootten 12505* (NMC).

Boraginaceae: *Nama carnosum* C.L. Hitchc.: *Spellenberg & Wootten 12503* (NMC), *Alexander 1325* (NMC, OC); *Tiquilia greggii* (Torr. & A. Gray) A.T. Richardson: *Moore et al. 2281* (OC, NMC, TEX/LL, MEXU); *Tiquilia hispidissima* (Torr.) A.T. Richardson: *Spellenberg & Wootten 12502* (NMC), *Moore et al. 2275* (MEXU, NMC, OC, TEX/LL).

Brassicaceae: *Nerisyrenia hypercorax* P.J. Alexander & M.J. Moore: *Spellenberg et al. 12442* (NMC), *Heil 34399* (SJNM), *Moore et al. 2272* (MEXU, NMC, OC, TEX/LL), *Alexander 1324* (DUKE, MEXU, MO, NMC, OC), *Alexander 1330* (DUKE, MEXU, MO, NMC, OC).

Cactaceae: *Coryphantha tuberculosa* (Engelm.) A. Berger: *Spellenberg & Wootten 12482* (NMC); *Cylindropuntia imbricata* (Haw.) F.M. Knuth; *Echinocactus horizonthalonius* Lemaire; *Echinocereus dasyacanthus* Engelm.: *Spellenberg & Wootten 12486* (NMC); *Opuntia macrocentra* Engelm.: *Spellenberg & Wootten 12487* (NMC), *Spellenberg & Wootten 12488* (NMC); *Opuntia phaeacantha* Engelm.

Ephedraceae: *Ephedra aspera* S. Watson: *Spellenberg & Wootten 12473* (NMC).

Euphorbiaceae: *Chamaesyce fendleri* (Torr. & A. Gray) Small: *Spellenberg & Wootten 12458* (NMC), *Spellenberg & Wootten 12471* (NY); *Chamaesyce serrula* (Engelm.) Wooton & Standl.: *Alexander 1332* (NMC); *Croton dioicus* Cav.

Fabaceae: *Dalea formosa* Torr.; *Dermatophyllum guadalupense* (B.L. Turner & A.M. Powell) B.L. Turner: *Urban 5072* (NMC); *Vachellia vernicosa* (Britton & Rose) Seigler & Ebinger.

Fouquieriaceae: *Fouquieria splendens* Engelm.

Krameriaceae: *Krameria erecta* Schult.: *Spellenberg & Wootten 12478* (NMC).

Lamiaceae: *Hedeoma nana* (Torr.) Briq.: *Spellenberg & Wootten 12479* (NMC), *Heil 34396* (SJNM).

Linaceae: *Linum vernale* Wooton: *Spellenberg & Wootten 12480* (NMC).

Loasaceae: *Cevallia sinuata* Lag.: *Worthington 30285* (UNM, UTEP); *Mentzelia humilis* (A. Gray) J. Darl. var. *guadalupensis* Spellenb.: *Spellenberg & Wootten 12440* (NMC), *Spellenberg & Wootten 12455* (NMC, NY, TEX, UNM), *Spellenberg & Wootten 12500* (NMC, RM), *Worthington 30287* (UCR, UTEP), *Heil & O'Kane 33495* (SJNM), *Heil & Schleser 34725* (SJNM), *Moore et al. 2273* (MEXU, NMC, OC, TEX/LL).

Malvaceae: *Sphaeralcea coccinea* (Nutt.) Rydb.: *Spellenberg & Wootten 12476* (NMC).

Nyctaginaceae: *Acleisanthes lanceolata* (Wooton) R.A. Levin: *Spellenberg & Wootten 12452* (NMC), *Spellenberg & Wootten 12499* (NMC), *Heil & Schleser 34726* (SJNM), *Moore et al. 2277* (MEXU, NMC, OC, TEX/LL); *Allionia incarnata* L. var. *incarnata*; *Anulocaulis leiosolenus* (Torr.) Standl. var. *howardii* Spellenb. & Wootten: *Wootten & Howard s.n.* (NMC), *Spellenberg et al. 12433* (NMC, NY, UNM), *Spellenberg et al. 12435* (NMC), *Spellenberg et al. 12438* (NMC), *Worthington 30288* (UCR, UTEP), *Heil & O'Kane 33493* (SJNM), *Moore et al. 2270* (MEXU, NMC, OC, TEX/LL); *Cyphomeris gypsophiloides* (M. Martens & Galeotti) Standl.: *Heil & Schleser 34722* (SJNM); *Mirabilis linearis* (Pursh) Heimerl: *Spellenberg & Wootten 12506* (NMC).

Oleaceae: *Menodora scabra* A. Gray: *Heil 34403* (SJNM).

Onagraceae: *Oenothera hartwegii* Benth. subsp. *filifolia* (Eastw.) W.L. Wagner & Hoch: *Spellenberg & Wootten 12472* (NMC), *Heil 34401* (SJNM), *Moore et al. 2276* (OC, NMC, US); *Oenothera suffrutescens* (Seringe) W.L. Wagner & Hoch.

Poaceae: *Achnatherum curvifolium* (Swallen) Barkworth: *Spellenberg & Wootten 12477* (NMC, NY); *Aristida purpurea* Nutt. var. *nealleyi* (Vasey) Allred: *Spellenberg & Wootten 12453* (NMC); *Aristida pansa* Wooton & Standl. var. *pansa*: *Spellenberg & Wootten 12456* (NMC); *Bothriochloa laguroides* (DC.) Herter subsp. *torreyana* (Steud.) Allred & Gould: *Spellenberg & Wootten 12459* (NMC); *Bouteloua warnockii* Gould & Kapadia: *Spellenberg et al. 12443* (NMC), *Heil 34392* (SJNM); *Dasyochloa pulchella* (Kunth) Willd. ex Rydb.; *Digitaria cognata* (Schult.) Pilg. subsp. *pubiflora* Wipff & Hatch: *Spellenberg & Wootten 12457* (NMC); *Enneapogon desvauxii* P. Beauv.; *Setaria leucopila* (Scribn. & Merr.) K. Schum.; *Sporobolus cryptandrus* (Torr.) A. Gray: *Spellenberg & Wootten 12504* (NMC); *Sporobolus nealleyi* Vasey: *Moore et al. 2271* (MEXU, NMC, OC, TEX/LL); *Tridens muticus* (Torr.) Nash var. *muticus*: *Spellenberg & Wootten 12454* (NMC), *Heil & Schleser 34720* (SJNM).

Polygonaceae: *Eriogonum havardii* S. Watson: *Spellenberg et al. 12439* (NMC), *Heil & O'Kane 33494* (SJNM, UNM), *Heil 34404* (SJNM).

Pteridaceae: *Astrolepis cochisensis* (Goodd.) D.M. Benham & Windham subsp. *chihuahuensis* D.M. Benham: *Spellenberg et al. 12444* (NMC), *Alexander 1333* (NMC); *Cheilanthes feei* T. Moore: *Alexander 1331* (WICH).

Rosaceae: *Fallugia paradoxa* (D. Don) Endl.

Rubiaceae: *Hedyotis nigricans* (Lam.) Fosberg var. *nigricans*: *Spellenberg et al. 12445* (NMC), *Moore et al. 2282* (MEXU, NMC, OC, TEX/LL); *Hedyotis* cf. *nigricans* (Lam.) Fosberg: *Moore et al. 2284* (OC, NMC, TEX/LL, MEXU).

Solanaceae: *Chamaesaracha pallida* Averett: *Heil 34402* (SJNM), *Alexander 1326* (NMC); *Nicotiana trigonophylla* Dunal.

Verbenaceae: *Aloysia wrightii* A. Heller.

APPENDIX 2

The following list includes all species observed by the first author on gypsum on the east side of Big Dog Canyon. Specimen vouchers and nomenclature are as described for Appendix 1.

Amaranthaceae: *Atriplex canescens*.

Asparagaceae: *Dasylirion leiophyllum*; *Yucca elata*.

Asteraceae: *Bahia absinthifolia* Benth.; *Gutierrezia microcephala*; *Haploësthes greggii* var. *texana*: *Alexander 1318* (NMC, OC); *Parthenium incanum; Porophyllum scoparium*; *Sartwellia flaveriae*; *Sidneya tenuifolia*; *Thelesperma megapotamicum*; *Thymophylla acerosa* (DC.) Strother.

Boraginaceae: *Tiquilia hispidissima*: *Alexander 1317* (NMC, OC).

Brassicaceae: *Nerisyrenia linearifolia* (S. Watson) Greene: *Alexander 1319* (NMC, OC).

Cactaceae: *Echinocereus dasyacanthus*; *Opuntia phaeacantha*.

Ephedraceae: *Ephedra aspera*.

Euphorbiaceae: *Chamaesyce fendleri*; *Croton dioicus*.

Fabaceae: *Dalea wrightii* A. Gray.

Fouquieriaceae: *Fouquieria splendens*.

Lamiaceae: *Salvia lycioides* A. Gray: *Alexander 1315* (NMC).

Loasaceae: *Cevallia sinuata; Mentzelia humilis* (A. Gray) J. Darl. var. *humilis*: *Alexander 1321* (NMC, OC).

Nyctaginaceae: *Acleisanthes lanceolata: Alexander 1316* (NMC, OC); *Allionia incarnata* var. *incarnata*.

Oleaceae: *Menodora scabra*.

Onagraceae: *Oenothera suffrutescens*.

Poaceae: *Bouteloua curtipendula* Torr.; *Enneapogon desvauxii; Muhlenbergia porteri* Scribn. ex Beal; *Sporobolus nealleyi: Alexander 1320* (NMC, OC); *Tridens muticus* var. *muticus*.

Pteridaceae: *Astrolepis cochisensis* subsp. *chihuahuensis*.

Rosaceae: *Fallugia paradoxa*.

Rubiaceae: *Hedyotis nigricans* var. *nigricans*.

Verbenaceae: *Aloysia wrightii*.

ACKNOWLEDGMENTS

We would like to thank the following individuals for assistance with this study: Michael Howard of the BLM Field Office, Las Cruces, helped arrange site access; George Rauch and Jonna Lou Schafer, ranchers on Crow Flats, allowed access to Pup Canyon across private land; Rich Spellenberg, Wynn Anderson, Chris Martine, and Krissa Skogen assisted with field work; Ken Heil and Gregory Penn provided information on specimens at SJNM. This work was supported by National Science Foundation grant DEB-1054539 and by the National Geographic Society. The careful reviews of Ihsan Al-Shehbaz and an anonymous reviewer are greatly appreciated.

REFERENCES

Allred, K.W. & R.D. Ivey. 2012. Flora Neomexicana III: An illustrated identification manual. Published by the authors at http://lulu.com.

Al-Shehbaz, I.A. 2012. A generic and tribal synopsis of the Brassicaceae (Cruciferae). Taxon 61(5): 931–954.

Anderson, R.Y. & W.E. Dean. 1995. Filling the Delaware Basin: Hydrologic and climatic controls on the Upper Permian Castile Formation varved evaporite. In: The Permian of Northern Pangea, Volume 2: Sedimentary basins and economic resources. P.A. Scholle, T.M. Peryt, & D.S. Ulmer-Scholle, eds. Springer Berlin Heidelberg, Berlin, Germany. Pp. 61–78.

APG III. 2009. An update of the Angiosperm Phylogeny Group classification for the orders and families of flowering plants: APG III. Bot. J. Linn. Soc. 161:105–121.

Bacon, J.D. 1978. Taxonomy of *Nerisyrenia* (Cruciferae). Rhodora 80(822):159–227.

Boyd, D.W. 1958. Permian sedimentary facies, central Guadalupe Mountains, New Mexico. State Bureau of Mines and Mineral Resources, New Mexico Institute of Mining and Technology, Socorro, New Mexico, U.S.A.

Damschen, E.I., S. Harrison, D.D. Ackerley, B.M. Fernandez-Going, & B.L. Anacker. 2012. Endemic plant communities on special soils: early victims or hardy survivors of climate change? J. Ecol. 100:1122–1130.

Elias, S.A. & T.R. Van Devender. 1992. Insect fossil evidence of late Quaternary environments in the northern Chihuahuan Desert of Texas and New Mexico: Comparisons with the paleobotanical record. S.W. Naturalist 37:101–116.

Escudero, A., S. Palacio, F.T. Maestre, & A.L. Luzuriaga. 2014. Plant life on gypsum: a review of its multiple facets. Biol. Reviews: Early View. DOI: 10.1111/brv.12092

King, P.B. 1948. Geology of the southern Guadalupe Mountains. United States Geological Survey, Professional Paper 215. http://www.nps.gov/history/history/online_books/gumo/215/index.htm

Moore, M.J. & R.K. Jansen. 2007. Origins and biogeography of gypsophily in the Chihuahuan Desert plant group *Tiquilia* subg. *Eddya* (Boraginaceae). Syst. Bot. 32: 392–414.

Moore, M.J., J.F. Mota, N.A. Douglas, H. Flores Olvera, & H. Ochoterena. 2014. The ecology, assembly, and evolution of gypsophile floras. In: Plant ecology and evolution in harsh environments. N. Rajakaruna, R. Boyd, & T. Harris, eds. Nova Science Publishers, Hauppauge, New York, U. S. A. Pp. 97–128.

New Mexico Rare Plant Technical Council. 1999–2012. New Mexico rare plants. Albuquerque, New Mexico, U.S.A. http://nmrareplants.unm.edu (Latest update: 30 Mar 2012).

Powell, A.M. & B.L. Turner. 1977. Aspects of the plant biology of the gypsum outcrops of the Chihuahuan Desert. In: Transactions of the symposium on the biological resources of the Chihuahuan Desert region, United States and Mexico, Sul Ross State University, Alpine, Texas, 17–18 October 1974. R.H. Wauer & D.H. Riskind, eds. National Park Service Transactions and Proceedings Series, Number 3. U.S. Department of the Interior, Washington, DC, U.S.A. Pp. 315–325.

Poole, J.M., W.R. Carr, D.M. Price, & J.R. Singhurst. 2007. Rare plants of Texas: A field guide. Texas Parks and Wildlife Department, Austin, Texas, U.S.A.

Rollins, R.C. 1993. The Cruciferae of Continental North America. Stanford University Press, Stanford, California, U.S.A.

Scholle, P.A. 2003. Geologic map of New Mexico, scale 1:500,000. New Mexico Bureau of Geology and Mineral Resources, New Mexico Institute of Mining and Technology, Socorro, New Mexico, U.S.A.

SEINet (Southwest Environmental Information Network). 2009–2013. http://swbiodiversity.org/seinet/index.php (Accessed Sep–Nov 2013).

Spellenberg, R.W. & T. Wootten. 1999. Vascular plants on a gypsum outcrop in southern New Mexico: A listing, a new variety and taxonomic realignments in the *Anulocaulis leiosolenus* complex (Nyctaginaceae), and a new variety of *Mentzelia humilis* (Loasaceae). Sida 18(4):987–999.

Thiers, B. 1997–2013. Index Herbariorum: a global directory of public herbaria and associated staff. New York Botanical Garden, New York, New York, U.S.A. http://sweetgum.nybg.org/ih/ (Accessed Nov 2013).

Turner, B.L. 1993. New species and combinations in *Nerisyrenia* (Brassicaceae) of Mexico. Phytologia 75:231–234.

Van Devender, T.R. 1990. Late Quaternary vegetation and climate of the Chihuahuan Desert, United States and Mexico. In: Packrat middens: The last 40,000 years of biotic change. J.L. Betancourt, T.R. Van Devender, & P.S. Martin, eds. University of Arizona Press, Tucson, Arizona, U.S.A. Pp. 104–133.

Weber, R.H. & F.E. Kottlowski. 1959. Gypsum resources of New Mexico. State Bureau of Mines and Mineral Resources Bulletin 68. New Mexico Institute of Mining and Technology, Socorro, New Mexico, U.S.A.

BOOK REVIEW

Thomas N. Taylor, Michael Krings, Edith L. Taylor. 2015. **Fossil Fungi.** (ISBN 978-0-12-387731-4, hbk.). Academic Press (Elsevier), 32 Jamestown Road, London NW1 7BY, U.K. (**Orders:** http://store.elsevier.com). $150.00, 398 pp., illustrated, 10.75" × 8.5".

The primary focus of this book is to record the history of fungi through time and highlight fossil associations between fungi and other organisms. The work is arranged in 13 chapters with Chapter 1 defining the field of Paleomycology as the study of fossil evidence of fungi and their activities through geologic time. Chapter 2 discusses the formation of fossil fungi and procedures used in their investigation. Chapter 3 examines the age of fungi while Chapters 4–9 cover the various taxonomic groups: Chytridiomycota, Blastocladiomycota, Zygomycetes, Glomeromycota, Ascomycota, and Basidiomycota. Chapter 10 deals with fossil lichens, Chapter 11 examines fungal spores, Chapter 12 investigates interactions between fungi and other organism, and Chapter 13 explores bacteria and fungus-like organisms, including the enigmatic Peronosporomycetes, puzzling organisms that may represent the first eukaryotes on Earth. Also included are a glossary, references, and index.

Many discoveries of the earliest known representatives of fungal groups have been made from the marvelously preserved fossils of the Early Devonian Rhynie chert beds. The Rhynie chert site, dated at some 410 million years BP, represented a subtropical wetland ecosystem consisting of an alluvial plain with small bodies of water, including hot springs. Both aquatic and terrestrial life forms were preserved, and one of the many fungal organisms recovered at this site was Paleopyrenomycites devonicus, now considered the earliest known ascomycete (Fig. 1). A section in the book covering fossil parasitic fungi shows that these organisms have been attacking plants, insects, and even nematodes for a considerable period of time.

The entire book is filled with high-quality color and black and white photos of a variety of fossil fungi as well as photos of past and current researchers and educators that dedicated a portion of their lives to this field. Fossil Fungi, the first book in this discipline, provides a stimulating introduction to the world of Paleomycology, and the pleasant writing style and beautiful color photos make it a pleasure to read.—*George Poinar, Jr., Department of Integrative Biology, Oregon State University, Corvallis, Oregon 97331, U.S.A.*

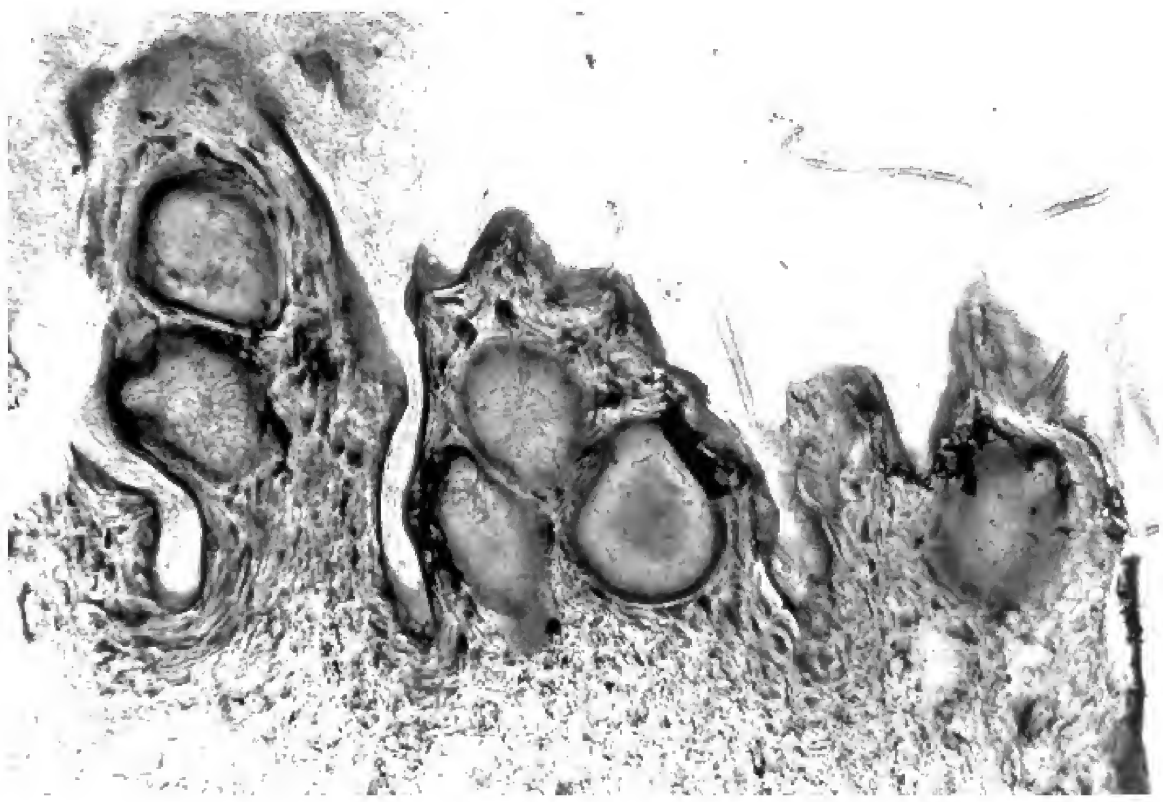


Fig. 1. The spectacular preservation of Early Devonian Rhynie chert fossils is exemplified by these ascomycetous perithecia of *Paleopyrenomycites devonicus* developing in the vascular plant *Asteroxylon* (photo courtesy of T.N. Taylor).

LOMATIUM SWINGERAE: A NEW SPECIES OF *LOMATIUM* (UMBELLIFERAE) FROM THE JOSEPH PLAINS, IDAHO, U.S.A.

Richard P. McNeill

1507 S Gonzales Street
Las Vegas, New Mexico 87701, U.S.A.
juniper.botany@gmail.com

ABSTRACT

Lomatium swingerae R.P. McNeill is a new species described from one population on the Joseph Plains, between the Salmon River and Snake River, Idaho, U.S.A. It co-occurs with *L. cous* and is morphologically most similar to *L. bicolor* var. *leptocarpum*. It is easily distinguished from *L. cous* based on morphology of the ultimate segments, involucral bractlets and mericarps, and from *L. bicolor* var. *leptocarpum* based on habitat, overall size of the plant, structure of the primary and secondary umbels, the ultimate segments and phenology.

RESUMEN

Lomatium swingerae R.P. McNeill es una nueva especie que se describe de una población de José Llanos, entre el río Salmón y el río Snake, Idaho, EE.UU. Se da junto con *L. cous* y es morfológicamente muy similar a *L. bicolor* var. *leptocarpum*. Se distingue fácilmente de L. cous por la morfología de los segmentos finales, brácteas involucrales y mericarpos, y de *L. bicolor* var. *leptocarpum* por su hábitat, el tamaño total de la planta, la estructura de las umbelas primarias y secundarias, los segmentos finales y fenología.

KEY WORDS: New species, *Lomatium*, *Lomatium swingerae*, Umbelliferae, Apiaceae, Salmon River, Snake River, Idaho, Endemic, Joseph Plains

Distinctive landforms and geomorphic processes in conjunction with large-scale patterns of climate change have resulted in unusual patterns of plant distribution in North Idaho. Consequently, it is home to many rare and endemic species, and many disjunct populations of species that are normally distributed either west of the Cascade Mountains or east of the Rocky Mountains (Brunsfeld et al. 2001; McNeill 2012). In 2008, I discovered an anomalous taxon of *Lomatium* on the Joseph Plains, the most northern point of land separating the Salmon River and the Snake River (Fig. 1). It was not possible to key this taxon reliably in the Flora of the Pacific Northwest or the Intermountain Flora (Cronquist et al. 1994; Hitchcock et al. 1961). I revisited the site four times between 15 May 2008–3 July 2014 attempting to collect specimen with mature fruit and to locate other populations. Mature fruits were finally collected on 3 July 2014 and no other populations have been found. The taxon was locally common, with approximately several thousand individuals occurring at the site, 86 individuals were collected for use in this description. Morphologically this species is most similar to *Lomatium bicolor* J.M. Coult. & Rose var. *leptocarpum* (Torr. & A. Gray) Schlessman and co-occurs with *L. cous* J.M. Coult. & Rose.

Lomatium swingerae R.P. McNeill, sp. nov. (**Figs. 2–3**). TYPE: U.S.A. IDAHO. IDAHO CO.: on ridge top along Divide Creek Road, on Joseph Plains between the Salmon River and the Snake River, ca. 8 km from junction with Flynn Creek Rd. and ca. 35 km W of Grangeville, elev. 1285 m, S slope of 0–15 %, 45.85183055°/-116.57732222°, dry open meadow in *Pinus ponderosa* forest, shallow, dry soils, very rocky, with mosses filling most of the rock interspaces, soil and rock derived from middle Miocene basalt flows, 27 May 2014, *Rick McNeill s.n.* (HOLOTYPE: ID; ISOTYPES: to be distributed).

Lomatium swingerae differs from congeners by geographical and/or ecological separation, phenology, leaf morphology, umbel size/structure, involucel bractlet shape, pedicel length, mericarp size/structure and root morphology.

Plants acaulescent, perennial, 6.5–32.0(–42.0) cm tall, glabrous to papillate. **Roots** tuberous thickened, moniliform, or globose, with a simple or rarely branched, subterranean caudex, 1.9–6.6 cm below ground level. **Leaves** basal, glabrous, 1–3 leaves per stem; **petioles** sheathing the stem, extending 0–80.8 mm beyond sheathing, old leaf bases ± present; **blades** 19.5–127.7 mm long, 18.8–229.2 mm wide, tripinnate, generally withered by the time the fruits are mature; **ultimate segments** 14–28 per 1 cm^2, acerose, with mucronate apices, 1.2–14.5 mm long, 0.1–0.9 mm wide, erect from either side of the rachis, pseudofasciculate and appearing

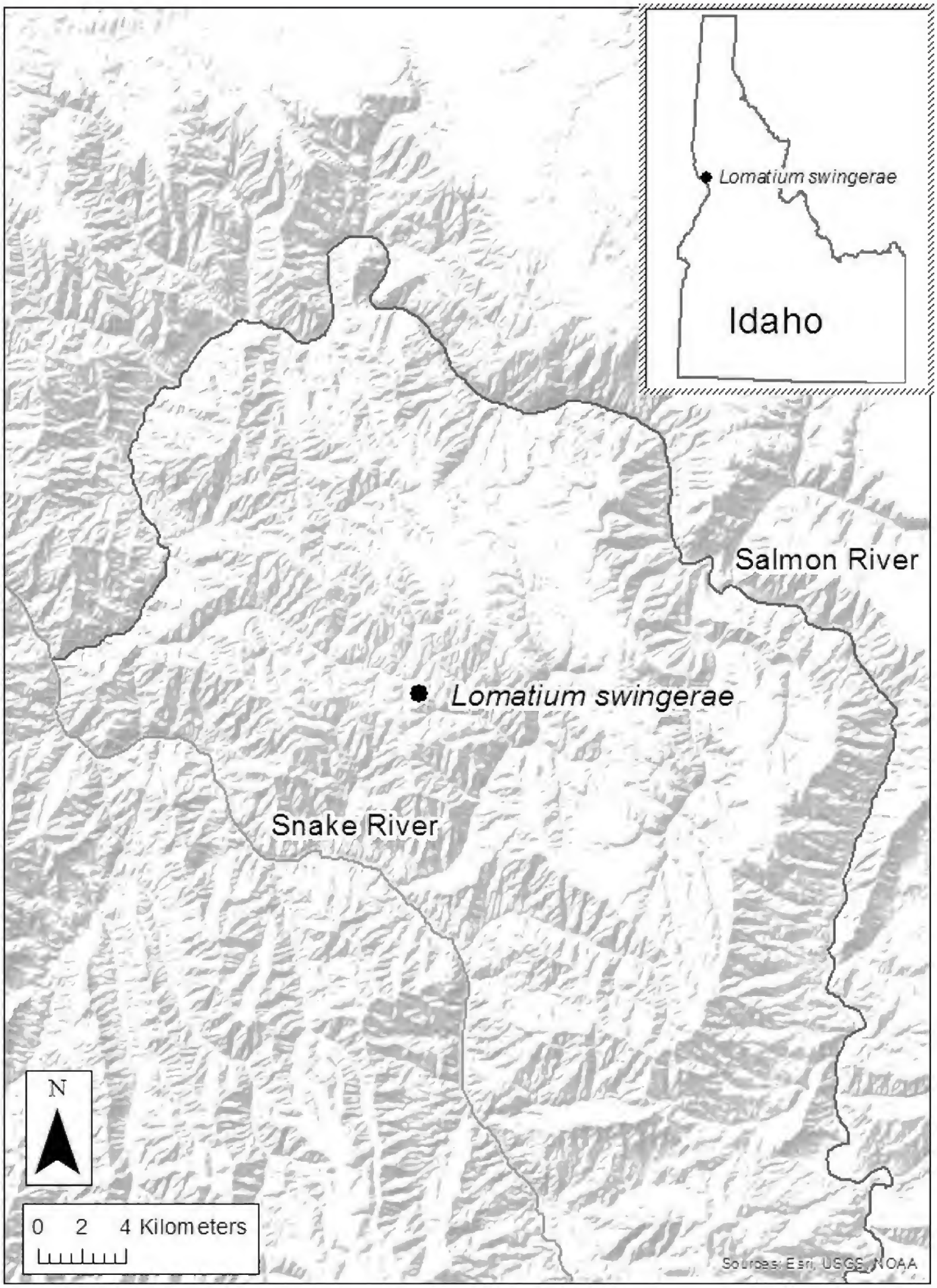


Fig. 1. Joseph Plains and the location of *Lomatium swingerae*.

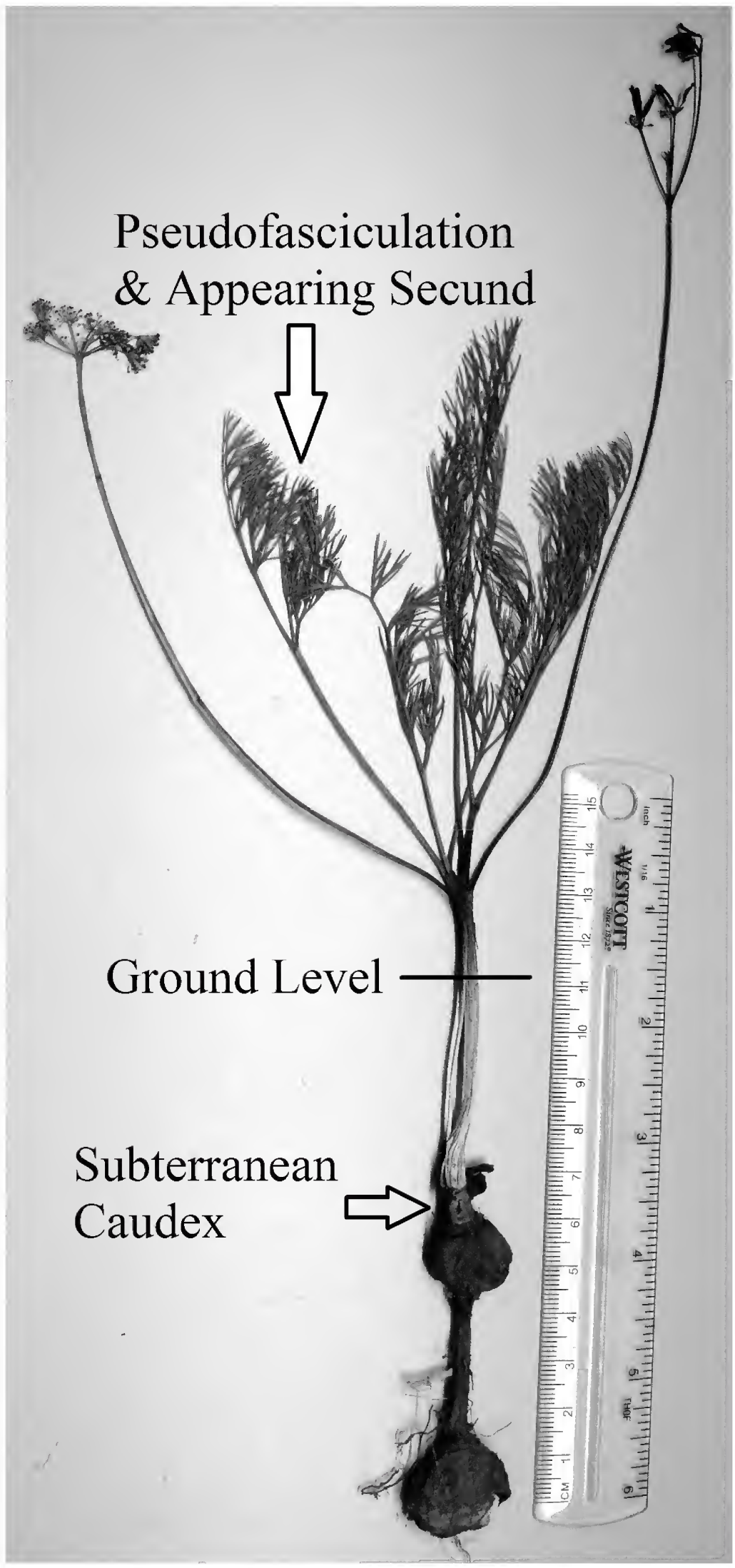


Fig. 2. *Lomatium swingerae*: habit (from holotype, *Rick McNeil s.n.*, ID), note subterranean caudex and pseudofasciculation of the leaflets with secund appearance.

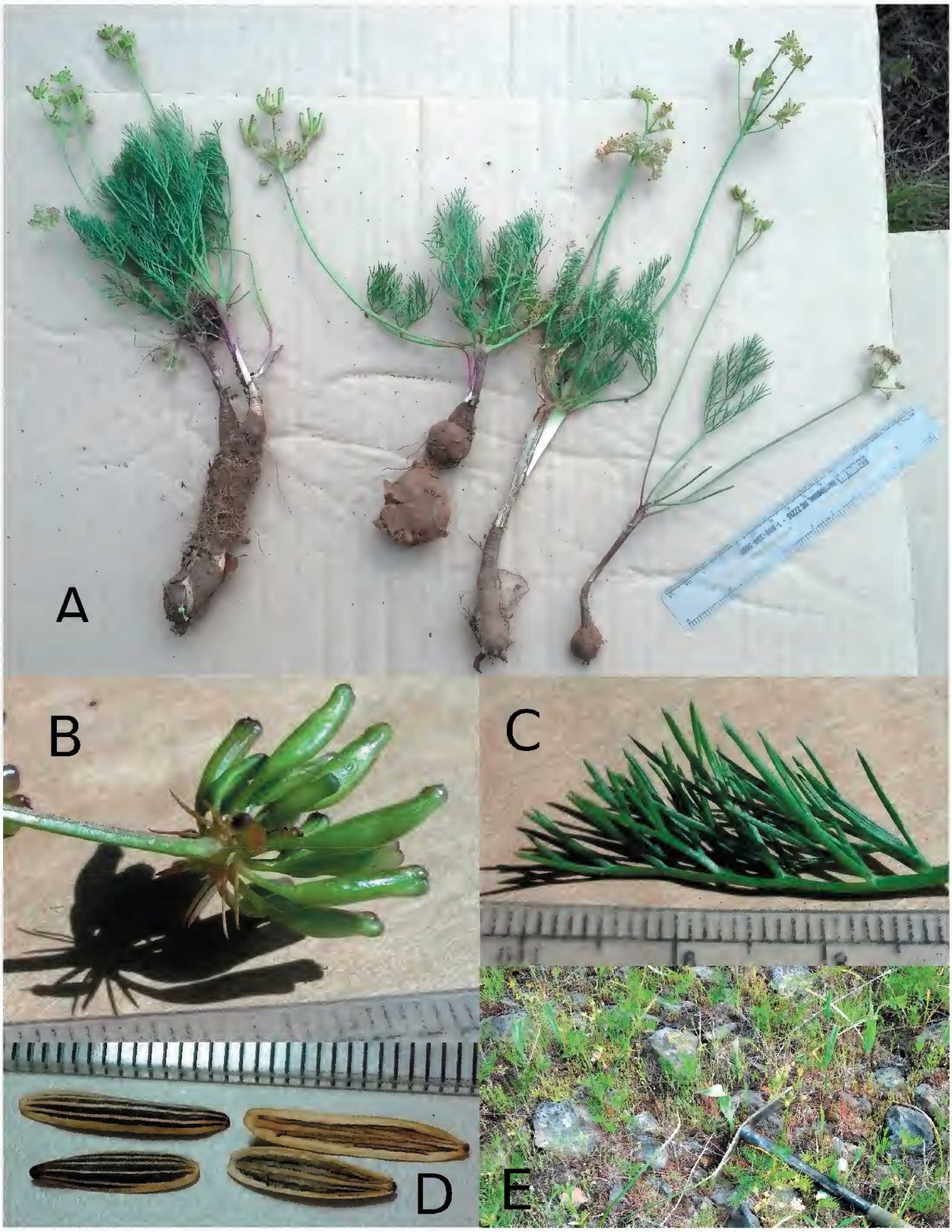


Fig. 3. *Lomatium swingerae* (all scale is mm or a 15 cm ruler): A. Root morphology and simple/branched caudices. B. Involucel bractlets and immature fruits. C. Ultimate segments of leaf: notice acerose form, pseudofasciculation and secund appearance. D. Mericarps: dorsal and ventral view, and E. Habitat.

secund. **Scapes** 1–3, 3.3–28.0(–38.5) cm long, ascending, corrugated, glabrous to papillate. **Inflorescence** compound umbel, glabrous to papillate; **involucre** absent; **rays** (1–)2–10, 10.9–60.4 mm long, ascending to erect. **Flowers sepals** 5, connate, inconspicuous; **petals** 5, yellow, obcordate; **ovary** superior, two carpellate, two styles, two yellow, exserted anthers, filaments yellow; **pedicels** 1–4.3(–6.2) mm long; **involucel bractlets** spreading to slightly reflexed at maturity, 0.3–2.1(–3.5) mm long, to 0.2 mm wide, narrowly lanceolate to narrowly oblanceolate, withering by the time the of mature fruits; **mericarps** ensiform or gladiate, deplanate or revolute, 10.0–16.5(–18.3) mm long, (0.87–)1.9–3.3(4.0) mm wide, lateral wings ± present, up to 0.5 mm wide, less than or equal to ⅕ as wide as the body, dorsal ribs 3(4); **vittae** interval 1 between each rib, commissural 2–4(–6), may be obscure, or incomplete; **stylopodia** yellowish tan, smooth to paleaceous; **carpophore** yellowish tan, 9.3–15.0 mm long.

Distribution and Phenology.—Occurring in a dry, open, rocky meadow. Flowering March through June and fruiting June through July.

Etymology.—The specific epithet is for Lindsay Ann Swinger, botanist and friend.

Lomatium swingerae is only superficially similar to *L. cous,* both tending to be small for Lomatiums; *L. swingerae* typically under 3.2 dm and *L. cous* typically under 3.5 dm. They can be distinguished from each other by the morphology of the mericarps, involucral bractlets, and the size and shape of the ultimate segments. The wings on the mericarps of *L. cous* are as wide or nearly as wide as the body, while in *L. swingerae* the lateral wings may or may not be present, if present, are up to ⅕ as wide as the body. *Lomatium cous* has broad, distinctive involucel bractlets that are oblanceolate, obovate or elliptic, while the bractlets of *L. swingerae* are narrowly lanceolate to narrowly oblanceolate. *Lomatium cous* has relatively broad (up to 3mm) and leaf-like ultimate segments, while on *L. swingerae* the ultimate segments are narrow (0.1–0.9 mm) and acerose. *Lomatium swingerae* can be distinguished from *Lomatium bicolor* var. *leptocarpum* by the arrangement and shape of the ultimate segments, the arrangement of the primary and secondary umbels, the size of the plant and habitat. *Lomatium bicolor* var. *leptocarpum* has ascending ultimate segments that are long (10–50 mm) and broad (0.5–2 mm), while the ultimate segments of *L. swingerae* are erect from both sides of the leaf rachis, pseudofasciculate, appearing secund, shorter (1.2–14.5 mm long) and narrower (0.1–0.9 mm wide). The primary umbel of *Lomatium bicolor* var. *leptocarpum* is appressed, while *L. swingerae* is erect to ascending. *Lomatium bicolor* var. *leptocarpum* has very crowded mericarps due their size and the short pedicels, while *L. swingerae* generally has smaller mericarps and longer pedicels that result in less crowding. *Lomatium bicolor* var. *leptocarpum* is generally 1–5 dm tall, while *L. swingerae* is generally no taller than 3.2 dm rarely, 4.2 dm, and finally *L. bicolor* var. *leptocarpum* occurs in wet meadows, and ephemeral pools, usually with high clay content soils, while *L. swingerae* is found in a dry, rocky meadow (Schlessman 1984).

Lomatium swingerae has only been found in one location, on the Joseph Plains, which is a high plateau separating the Salmon River and Snake River approximately 35 km west of Grangeville, ID. The Salmon River and Snake River have created canyons on three sides of the Joseph Plains that are approximately 980 m lower than the plains, and up to 16 km wide. *Lomatium swingerae* occurs in an open rocky meadow with very little soil development. The rocky interspaces are filled with mosses, soil, and roots. This soil and rock are derived from the middle Miocene flood-basalt flows, occurring between16–11.6 million years ago (Bond et al. 1978). Basalt-derived soils tend to be influenced more by climate than the mineral composition of the parent material, so the uniqueness of the habitat is likely due to the landscape position on top of an exposed, dry ridge rather than the result of any special properties of the basalt (Kruckeburg 2002). *Lomatium swingerae* flowers from March to June and the fruit mature in late June through July, with timing largely dependent on seasonal variation. It is also distinctive from the other *Lomatiums* on the Joseph Plains in that it flowers and fruits before the five other species: *Lomatium ambiguum* J.M. Coult. & Rose, *L. cous*, *L. dissectum* (Nutt. ex Torr. & A. Gray) Mathias & Constance, *L. bicolor* var. *leptocarpum* and *L. triternatum* J.M. Coult. & Rose ssp. *platycarpum* (Torr.) Cronquist. On 27 May 2014, *Lomatium swingerae* had green fruits, while all the other *Lomatiums* were in flower, and on 3 July 2014, both *L. swingerae* and *L. cous* had mature fruits, but *L. bicolor* var. *leptocarpum*, *L. triternatum* ssp. *platycarpum* and *L. dissectum* had immature fruits. Only *Lomatium cous* and *L. triternatum* ssp.

platycarpum have been found within 2 km of the population of *L. swingerae*. *Lomatium cous* and *L. swingerae* grow next to each other in the rocky areas of the meadow. In the nearby soils that are less rocky, deeper or wetter, only *L. cous* is found. *Lomatium triternatum* ssp. *platycarpum* is found on the edge of the meadow, in less rocky, deeper soils that are partially shaded by the trees. *Lomatium swingerae* occurs in association with the following species: *Allium tolmiei* Baker ex J.M. Coulter var. *platyphyllum* (Tidest.) Ownbey, *Balsamorhiza incana* Nutt., *Castilleja chromosa* A. Nelson, *Crepis atribarba* A. Heller ssp. *atribarba*, *Delphinium depauperatum* Nutt., *Erigeron bloomeri* A. Gray, *Erigeron englemannii* A. Nels., *L. cous* J.M. Coult. & Rose, *Microsteris gracilis* (Hook.) Greene var. *gracilis*, *Orobanche uniflora* L. var. *purpurea* (Heller) Achey, and *Poa bulbosa* L.

Paratypes: **U.S.A. IDAHO. Idaho Co.:** plateau between the Salmon and Snake Rivers, elev. 1259 m, 45°51.392'N, 116°34.493'W, S + N slope 1–40%, meadow in *Pinus ponderosa* woodland, rocky soil, 21 May 2008, *Rick McNeill s.n.* (ID); on ridge top along Divide Creek Road, on Joseph Plains between the Salmon River and the Snake River, ca. 8 km from junction with Flynn Creek Rd, and ca. 35 km W of Grangeville, elev. 1285 m, S slope: 0–15 %, 45.85183055°/-116.57732222°,dry open meadow in *Pinus ponderosa* forest, shallow, dry soils, very rocky, with mosses filling most of the rock interspaces, soil and rock derived from middle Miocene basalt flows, 3 Jul 2014, *Rick McNeill s.n.* (ID).

Lomatium swingerae is endemic to northern Idaho, known from only one population and should be considered for listing as a sensitive species. The limited geographic range and single known population make it extremely vulnerable to extirpation.

KEY TO *LOMATIUM* TAXA OF THE JOSEPH PLAINS, IDAHO

1. Involucel bractlets absent _____ **L. ambiguum**
1. Involucel bractlets present.
   2. Involucel bractlets broadly oblanceolate to broadly obovate or elliptic, wing of the mericarp equal or nearly as wide as the body, root tuberous thickened or globose _____ **L. cous**
   2. Not with the above combination of characters.
      3. Flowers purple, plants 5–15 (20) dm tall, large woody taproot _____ **L. dissectum**
      3. Flowers yellow, if plants over 5 dm tall, then slender taproot, or cormose thickened, not large and woody.
         4. Wing of the mericarp nearly as wide as the body, ultimate segments few, less than 10 per cm^2 _____ **L. triternatum** ssp. **platycarpum**
         4. Wing of the mericarp narrow, less than ⅕ of the body, ultimate segments many, more than 10 per cm^2.
            5. Plant growing in wet meadows or ephemeral pools, ultimate segments ascending, 1–5 cm long, 0.5–2 mm wide, rays of primary umbels appressed, mericarps crowded, root short and cormose thickened to more elongate and slender _____ **L. bicolor** var. **leptocarpum**
            5. Plants growing in dry rocky meadows, ultimate segments erect, pseudofasciculate, appearing secund, 0.1–1.5cm long, 0.1–0.9 mm wide, rays of primary umbels erect or ascending, mericarps not crowded, root globose, moniliform or tuberous thickened _____ **L. swingerae**

ACKNOWLEDGMENTS

I would like to thank Todd Ott for his help with collections, Cort Anderson for providing accommodations while I was collecting and Don Mansfield, and Stephen R. Downie for their thoughtful and timely reviews. The following herbaria contributed specimen, use of equipment and space to sort collections: the Stillinger Herbarium (ID) University of Idaho, the Rocky Mountain Herbarium (RM) University of Wyoming, and the Marion Ownbey Herbarium (WS) Washington State University. Finally, I would like to thank Barney Lipscomb for his help and patience.

REFERENCES

Bond, J.G., J.D. Kauffman, D.A. Miller, & R. Venkatakrishnan. 1978. Geologic map of Idaho. Idaho Bureau of Mines and Geology, with contributions from U.S. Geological Survey, scale 1:500,000.

Brunsfeld, S.J., J. Sullivan, D.E. Soltis, & P.S. Soltis. 2001. Comparative phylogeography of northwestern North America: a synthesis. In: J. Silverton, and J. Antonovics, eds. Integrating ecological and evolutionary processes in a spatial context. Blackwell Science, Oxford, UK. Pp. 319–339.

Cronquist, A., N.H. Holmgren, & P.K. Holmgren. 1994. Intermountain flora: vascular plants of the intermountain west, U.S.A., Vol. 3: part A subclass Rosidae (except Fabales). New York Botanical Garden Press, Bronx, NY, U.S.A.

Hitchcock, C.L., A. Cronquist, M. Ownbey, & J.W. Thompson. 1961. Vascular plants of the Pacific Northwest, part 3: Saxifragaceae to Ericaceae. University of Washington Press, Seattle, U.S.A.

Kruckeburg, A.R.2002.Geology and plant life: the effects of landforms and rock types on plants. University of Washington Press, Seattle.

McNeill, R.P. 2012. *Lomatium brunsfeldianum*: a new species of *Lomatium* (Umbelliferae) from Northern Idaho. J. Bot. Res. Inst. Texas 6(1):29–36.

Schlessman, M.A. 1984. Systematics of tuberous *Lomatiums* (Umbelliferae). Syst. Bot. Monogr. 4:1–55.

BOOK REVIEW

Jacques Cayouette. 2014. À la **Découverte du Nord: Deux siècles et demi d'exploration de la flore nordique du Québec et du Labrador.** (ISBN-13: 978-2-89544-471-8, hbk.). Éditions MultiMondes, 930 rue Pouliot, Québec, Québec G1V 3N9, CANADA (**Orders:** www.multim.com, 1-800-840-3029). $45.00, 363 pp., color photos, index, 8" × 10". French language text throughout.

The two and a half centuries covered in this book included many excursions into land that had scarcely been explored, the prodigious activity of botanists and others interested in the rich and unique life of a forbidding landscape. The Moravians, Europeans of one religion and several nationalities, came from their settlement in Greenland to establish a colony, Nain, in Labrador in 1771. With their respect for all creation, they collected plants which eventually found their way into the hands of private collectors in England, Germany, Sweden, and elsewhere and later into the herbariums of universities and museums. Their activity continued into the 1870s, with botanists such as Johannes Lundberg and Samuel Weiz continuing the work of their predecessors. From England, France, Denmark, Sweden, and the United States botanists, geologists, and zoologists came to collect, many taking specimens for deposit in their national and university herbariums. There was much to be found, not only in vascular plants but probably even more importantly in the bryophytes, lichens, and algae. Species of *Carex* and other Cyperaceae were of special interest because of the many forms these plants took in various habitats and different soil types.

From 1842 the Company of Hudson Bay also took a large role in exploration as did later the Canadian Geological Commission with the Geological and Natural History Survey of Canada. Both of these governmental units contributed much to the knowledge of the plants of northern Quebec and Labrador. However, it was work in the early and middle twentieth century that really led to a complete understanding of the floral heritage of these regions of Canada, knowledge which resulted in the first volume of the comprehensive *Flore Nordique* in 2013. Notable individuals among the botanists active in this period include the indomitable priest Marie-Victorin (1885–1944), Jacques Rousseau (1905–1970), Nicholas Polunin (1909–1997), Ilmari Hustich (1911–1982), and Marcel Raymond (1915–1972).

This work is not only a detailed, scholarly history of the development of knowledge of the alpine-boreal plant communities, but in fact is a kind of festschrift to all those individuals who have contributed so much to the science. There are pictures of some of their mounted herbarium specimens and of their publications, scientific and popular, and color photographs of plants in situ that they wrote about. The numerous color photos of beautiful plants and geographic regions add much to the pleasure of reading about those who discovered and described them. The bibliography lists the publications, some extensive, of these persons as they made known to the world their discoveries. Of interest to many botanists may be particular entries in the Index, for example 56 taxa of *Carex*, 14 of *Eriophorum*, 11 of *Draba*. This volume is an important addition to the botanical history of North America.—*Joann Karges, Texas Christian University Library (retired), Fort Worth, Texas, U.S.A.*

NEW GEOGRAPHICAL AND MORPHOLOGICAL DATA FOR *SIDEROXYLON RECLINATUM* SUBSPECIES *AUSTROFLORIDENSE* (SAPOTACEAE), A TAXON ENDEMIC TO SOUTHEASTERN PENINSULAR FLORIDA, U.S.A.

Paul T. Corogin and Walter S. Judd

Department of Biology
220 Bartram Hall
and
Florida Museum of Natural History
University of Florida
Gainesville, Florida 32611, U.S.A.
pcorogin@ufl.edu; lyonia@ufl.edu

ABSTRACT

Sideroxylon reclinatum Michx. subspecies *austrofloridense* (Whetstone) Kartesz & Gandhi is re-diagnosed in light of new morphological data, compared with its presumed closest relatives, and the extent of its distribution is clarified. *Sideroxylon reclinatum* subsp. *austrofloridense* is endemic to subtropical rockland habitats of extreme southeastern peninsular Florida, U.S.A. These habitats face threats from exotic species invasions, fire suppression, and sea-level rise due to climate change. *Sideroxylon rufohirtum* Herring & Judd, sometimes considered a subspecies of *S. reclinatum* Michx., is here recognized as a separate species.

RESUMEN

Se vuelve a diagnosticar *Sideroxylon reclinatum* Michx. subspecie *austrofloridense* (Whetstone) Kartesz & Gandhi a la luz de nuevos datos morfológicos, comparados con los de sus presuntos parientes más próximos, y se clarifica la extensión de su distribución. *Sideroxylon reclinatum* subsp. *austrofloridense* es endémico de hábitats rocosos subtropicales del extremo sureste peninsular de Florida, U.S.A. Estos hábitats se enfrentan a amenazas de invasiones de especies exóticas, supresión por fuego, y elevación del nivel del mar por cambio climático. *Sideroxylon rufohirtum* Herring & Judd, a veces considerado como subespecie de *S. reclinatum* Michx., se reconoce aquí como una especie diferente.

INTRODUCTION

Sideroxylon L. (Sapotaceae) is a pantropical genus comprising ca. 80 species, occurring most abundantly in tropical America, but also in Macaronesia, Africa, Madagascar, and the Mascarene Islands, with few species in southeast Asia (Govaerts et al. 2001; Smedmark & Anderberg 2007). Prior to Pennington's monographs of the Sapotaceae (1990, 1991), the Neotropical species of *Sideroxylon*, centered in the Caribbean and Central America and extending into the temperate southeastern U.S., were split among the genera *Bumelia* Sw., *Dipholis* A.DC., and *Mastichodendron* (Engl.) H.J. Lam. The species endemic to the continental U.S. (and extreme northern Mexico) were assigned to *Bumelia*, along with many tropical taxa (Cronquist 1945, 1946, 1949). They are trees and shrubs of mainly dry habitats, usually armed with thorns, with leaves alternate, often becoming fascicled on short shoots (brachyblasts), inflorescences fasciculate, axillary or in axils of fallen leaves, flowers with a single whorl of quincuncial sepals, corolla lobes with a median segment and two lateral segments, petaloid staminodes alternating with epipetalous stamens, and the seed having its hilum scar in a basal position, with endosperm scanty or lacking (Cronquist 1945). *Bumelia* was revised by Gray (1886), Small (1900), Clark (1942), and Cronquist (1945, 1949), all of whom differed concerning the number of U.S. species. Pennington (1990) transferred all of *Bumelia, Dipholis,* and *Mastichodendron* to a broadly circumscribed *Sideroxylon*, and for species limits he generally followed Cronquist, recognizing eight U.S. species. More recently, phylogenetic analyses using both morphological and molecular data have shown that *Sideroxylon* sensu Pennington is monophyletic including *Argania* from Morocco (Anderberg & Swenson 2003; Swenson & Anderberg 2005;

Smedmark et al. 2006), but excluding two taxa from the Arabian peninsula and Socotra (Smedmark & Anderberg 2007; Gautier et al. 2013; Stride et al. in press). Although relationships among the major subclades of *Sideroxylon* are unclear, molecular phylogenies reveal two well-supported Neotropical subclades, one corresponding to *Dipholis/Mastichodendron*, and the other to *Bumelia*, including the species endemic to North America (Smedmark & Anderberg 2007; Stride et al. in press).

Currently eleven species of *Sideroxylon* are recognized in the continental United States (Govaerts et al. 2001; Allison 2006; Wunderlin & Hansen 2008). Of these eleven species, eight are endemic to an area encompassing much of the southeastern U.S. and a bit of extreme northern Mexico, most being concentrated on the coastal plain from Texas through the Carolinas, with Florida as their center of diversity (Govaerts et al. 2001; Allison 2006; Wunderlin & Hansen 2008). These eight are: *Sideroxylon alachuense* L.C. Anderson, *S. lanuginosum* Michx., *S. lycioides* L., *S. macrocarpum* (Nutt.) J.R. Allison, *S. reclinatum* Michx., *S. rufohirtum* Herring & Judd, *S. tenax* L., and *S. thornei* (Cronquist) T.D. Penn. The above-listed taxa, which likely form a monophyletic group (Smedmark & Anderberg 2007; Corogin and Judd, unpublished DNA sequence data), are distinguished morphologically from their tropical congeners by having a combination of fascicled leaves, conspicuously reticulate tertiary venation, short styles, small fruits, and a bipartite hilum scar (Pennington 1990). Common names include "buckthorn," "bully," and "bumelia."

Sideroxylon reclinatum is a mostly low-growing thorny shrub (occasionally a small tree) of calcareous or sandy, wet to mesic wooded habitats of Florida and the outer coastal plain from southern Georgia to Louisiana. Cronquist (1945) recognized two varieties, *Bumelia reclinata* (Michx.) Vent. var. *reclinata,* and *B. reclinata* var. *rufotomentosa* Cronquist, the latter having been previously recognized as a species (*B. rufotomentosa*) by Small (1900). Whetstone (1985) named a third variety, *B. reclinata* var. *austrofloridensis* Whetstone ("Everglades buckthorn"), based on morphologically distinct collections from subtropical rocklands in the vicinity of Long Pine Key in the Florida Everglades. Varieties *rufotomentosa* and *austrofloridensis* were transferred to *Sideroxylon* by Kartesz and Gandhi (1990), and recognized as *S. reclinatum* subsp. *rufotomentosum* (Small) Kartesz & Gandhi, and *S. reclinatum* subsp. *austrofloridense* (Whetstone) Kartesz & Gandhi, respectively. Based on consistent differences in morphology, habit, and habitat, Herring and Judd (1995) recognized *S. reclinatum* subsp. *rufotomentosum* as a distinct species, *Sideroxylon rufohirtum* Herring & Judd, (see Godfrey 1988), and this designation is here recognized. *S. reclinatum, S. rufohirtum,* and a third species, *S. macrocarpum* (Nutt.) J.R. Allison, are here referred to as the *Sideroxylon reclinatum* complex, as they share many similarities in morphology and habit and are traditionally presumed closely related. We discuss how *S. reclinatum* subsp. *austrofloridense* is distinguished from *S. reclinatum* subsp. *reclinatum*, and also from the other two species in the complex.

Our close examination of specimens including more recent collections, along with field observations of both *S. reclinatum* subsp. *reclinatum* and *S. reclinatum* subsp. *austrofloridense*, reveal that the two subspecies are most reliably distinguished by differences in the micromorphology of the abaxial leaf epidermis, and that the extent of distribution of subsp. *austrofloridense*, while limited to extreme southern peninsular Florida, is somewhat larger than was previously supposed.

The focus of this paper is the southern Florida subtropical rockland populations of *Sideroxylon reclinatum* that form subspecies *austrofloridense*. Our aim is to present new morphological and geographical data on these populations, to revise the circumscription and range of the subspecies in light of this new data, to compare the subspecies with its presumed closest relatives, and to discuss its importance and conservation status as part of the endemic flora of southern Florida rockland habitats. A comprehensive taxonomic treatment of *S. reclinatum*, including both subspecies, will be presented in an upcoming revision of the clade of *Sideroxylon* endemic to the continental U.S. and extreme northern Mexico.

MATERIALS AND METHODS

The morphological findings of this study are based on close examination of numerous specimens, both fresh and dried. Dried flowers were rehydrated by boiling in water, and dissected with the aid of a Wild M5A dissecting microscope (Aarau, Switzerland). Dimensions of trichomes were measured with the aid of a Carl Zeiss

4311036 compound microscope. Scanning electron microscopy (SEM) was employed for examination of leaf surface micromorphology. Leaf material from dried herbarium specimens of taxa being compared was mounted on carbon adhesive tabs on aluminum specimen mounts. Samples were rendered conductive by coating with a gold-palladium alloy in argon vacuum for 90 seconds using a Denton Desk V sputter coater (Denton Vacuum, Moorestown, NJ, USA). Samples were examined with a Hitachi S-4000 field-emission scanning electron microscope (Hitachi High Technologies America, Inc. Schaumburg, IL), and digital micrographs were acquired with PCI Quartz software. SEM work was conducted at the Electron Microscopy Core of the Interdisciplinary Center for Biotechnology Research (ICBR) at the University of Florida. From *Sideroxylon reclinatum* subsp. *reclinatum* and *S. reclinatum* subsp. *austrofloridense,* twelve individuals of each taxon were sampled; from *S. rufohirtum* and *S. macrocarpum*, five individuals of each taxon were sampled. Conclusions regarding the geographical range of *Sideroxylon reclinatum* subsp. *austrofloridense* are based on extensive field observations and data from herbarium specimen labels.

RESULTS AND DISCUSSION

Morphology.—The species of the *Sideroxylon reclinatum* complex share some morphological similarities such as low habit, small leaves with prominent vein reticulum, and abaxial leaf pubescence that is usually sparse, if present, and often deciduous. They are *Sideroxylon reclinatum*, *S. macrocarpum*, and *S. rufohirtum*. *Sideroxylon reclinatum* ranges throughout Florida, southwestern Georgia, and westward along the coastal plain to Louisiana, growing in mesic to wet, sandy to calcareous habitats. This species is not typically highly clonal, is generally low-growing but can reach heights of ca. 3 m as many-trunked shrubs or occasionally small trees, and has small fruits (10 mm diameter or less). It is usually a glabrous plant, any leaf or young stem pubescence quickly deciduous, except for the south Florida subspecies *austrofloridense*, in which pubescence can be persistent. *S. macrocarpum* is a low-growing, highly clonal shrub narrowly endemic to a few counties in southeast Georgia. It is similar in habit and habitat to *S. rufohirtum*, a putative close relative endemic to a few counties in north and west peninsular Florida (Allison 2006). These two species prefer dry sandy habitats, are both highly clonal and low-growing, rarely exceeding 1 m in height, and they have large fruits (> 10 mm diameter), young stems pubescent through the first season, and abaxial leaf pubescence that is sparse and often persistent.

Scanning electron microscope (SEM) images of the abaxial leaf cuticular surfaces of these species (Figs. 1, 2) reveal that the surface features of these taxa are quite distinct from one another. Previous SEM study has shown that taxa of *Sideroxylon* can be distinguished by such characters (Anderson 1996). Stomata in all cases are recessed inside chambers with generally elliptical openings. In both subspecies of *Sideroxylon reclinatum*, each chamber opening is surrounded by a series of irregularly concentric cuticular ridges, often also with ridges radiating out perpendicularly from the opening. The features of *Sideroxylon macrocarpum* and *S. rufohirtum* are rather different from those of *S. reclinatum* (Figs. 1, 2). The stomatal chambers of these species are somewhat larger than those of *S. reclinatum*. In *Sideroxylon macrocarpum,* each elliptic-shaped stomatal chamber opening sits atop a small dome raised above the epidermal surface, and surrounding the dome is a border of one or more concentric ridges; at least one of these ridges tends to form a striking, neatly defined oval border around the dome. The epidermal surface is strongly patterned, with impressed grooves defining cell outlines. The stomatal structures of *Sideroxylon rufohirtum* are distinctive as well, with stomatal chamber openings centered on conspicuously donut-shaped, broad, flat to slightly cupped, elevated platforms bordered by concentric cuticular ridging, and the cuticular surface between stomata is relatively smooth but with epidermal cell outlines visible and defined by impressed grooves.

At the macromorphological level, the two subspecies of *Sideroxylon reclinatum* are not always easily distinguishable (Table 1). Subspecies *reclinatum* is typically a glabrous plant. Abaxial leaf pubescence, if present at all, tends to be grey to white in color, the trichomes straight or weakly curled, and it is never dense or persistent; trichomes quickly slough off as the leaf matures, persisting only along the abaxial midvein if at all. Sepals and pedicels are glabrous, and the ovary is glabrous or with only a few scattered trichomes at anthesis (Fig. 3). The population of subspecies *austrofloridense* at Long Pine Key in the Everglades is morphologically quite distinct,

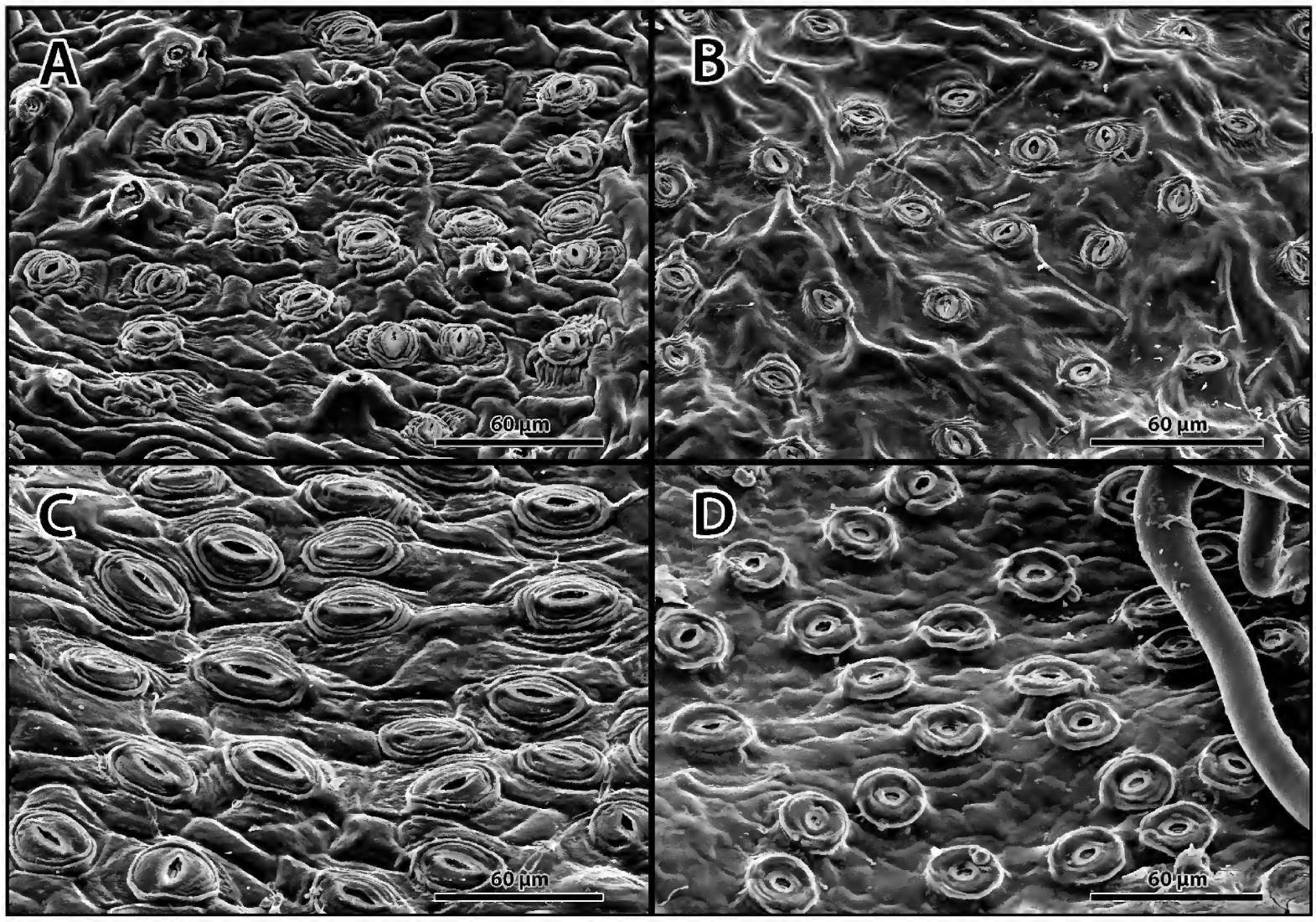


Fig. 1. SEM images of abaxial epidermal leaf surface of four taxa of *Sideroxylon*, showing differences in stomatal structures and cuticular surfaces. A: *S. reclinatum* subsp. *austrofloridense* (*Corogin 1055*, FLAS); B: *S. reclinatum* subsp. *reclinatum* (*Corogin 1060*, FLAS); C: *S. macrocarpum* (*Allison 9404*, USCH); D: *S. rufohirtum* (*Corogin 1000*, FLAS). (Magnification 500×).

Table 1. Comparison of key morphological differences between *Sideroxylon reclinatum* subsp. *austrofloridense* and *S. reclinatum* subsp. *reclinatum*.

	subsp. *austrofloridense*	subsp. *reclinatum*
Pubescence, abaxial surface of leaf	Sparse to dense, finely wooly, matted, sometimes obscuring leaf surface. Persistent across all of lamina, or quickly deciduous, leaving surface glabrous. Most trichomes strongly curled, ascending, light brown, fading to gray.	Sparse to absent. Quickly deciduous, persistent only along midvein if at all. Trichomes fine, straight to weakly curled, appressed or ascending, light brown to white.
Ovary at anthesis	Sparsely to densely pubescent.	Glabrous or with only a few scattered trichomes.
Sepals at anthesis	Glabrous to densely pubescent.	Glabrous or with only a few scattered trichomes.
Stomatal structures	Cuticular ornamentations around chamber openings are of low to moderate relief.	Cuticular ornamentations around chamber Openings are of moderate to strong relief
Cuticular surface, leaf abaxial (at high magnification)	Epidermal cell outlines always clearly visible and marked by an impressed groove. Surface elaborately ornamented with reticulate pattern in strong relief.	Epidermal cell outlines not always clearly visible, and not marked by an impressed groove. Surface generally smooth and irregularly undulating.

readily distinguishable at a glance from subspecies *reclinatum* by the persistent matted wooly brown pubescence on the abaxial leaf surfaces and often also on the sepals and pedicels, and the ovary is densely to sparsely pubescent at anthesis (Fig. 3). Whetstone (1985) diagnosed subspecies *austrofloridense* based on specimens having these features. But our examination of many south Florida specimens, and recent observations in the field, indicate that plants from locations outside of Long Pine Key (and even a few at Long Pine Key) have a

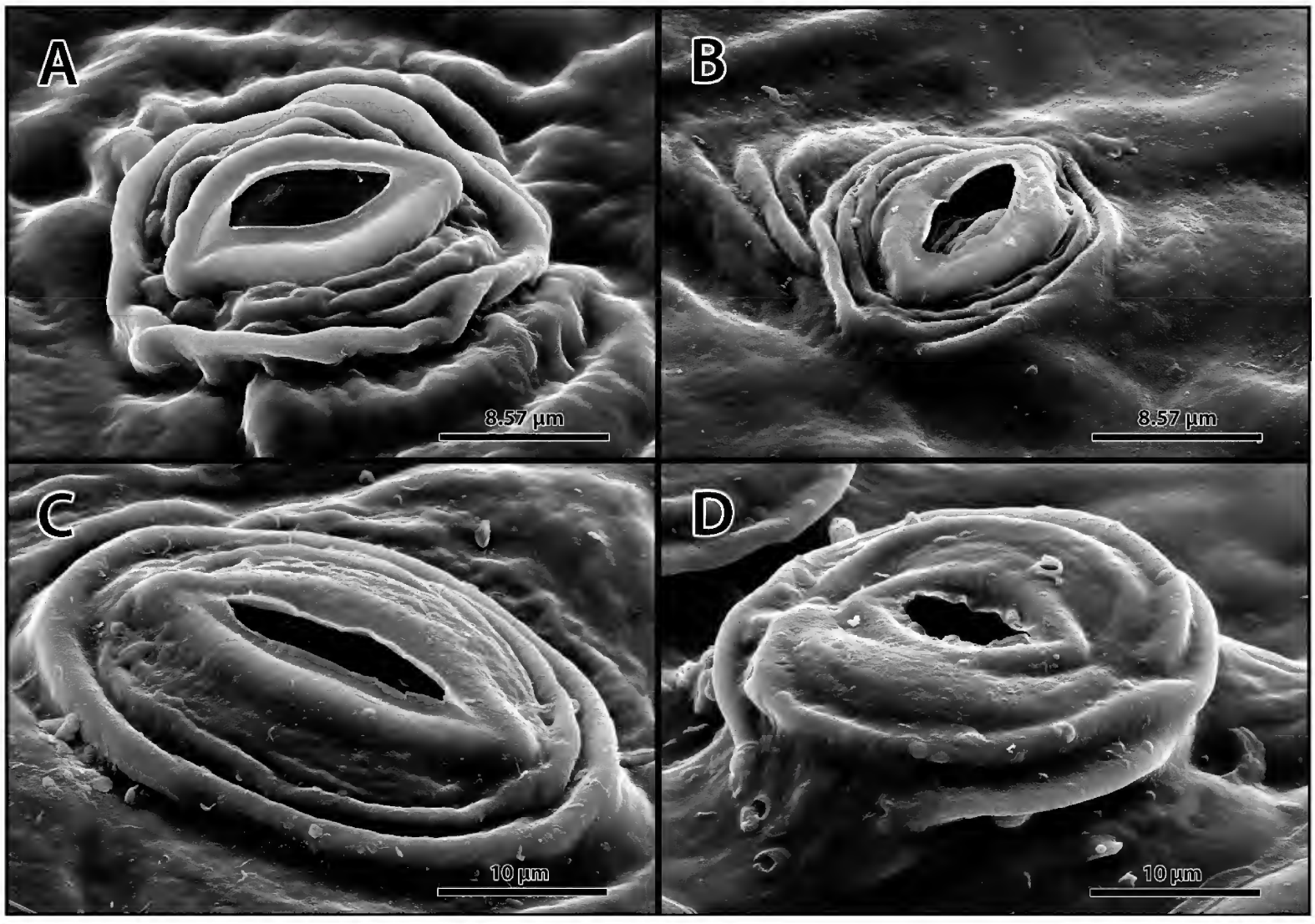


Fig. 2. SEM close-up views of stomatal structures of four taxa of *Sideroxylon*. At magnification 3500×; A: *S. reclinatum* subsp. *austrofloridense* (*Corogin 1055*, FNPS); B: *S. reclinatum* subsp. *reclinatum* (*Godfrey 81581*, FTG). At magnification 3000×; C: *S. macrocarpum* (*Allison 9404*, USCH); D: *S. rufohirtum* (*Ward 1206*, FLAS). Note the relative sizes—structures of *S. macrocarpum* and *S. rufohirtum* are somewhat larger than those of *S. reclinatum* subsp. *austrofloridense* and *S. reclinatum* subsp. *reclinatum*.

sparser and less persistent leaf indumentum, appearing nearly glabrous, many of them most closely resembling subspecies *reclinatum*. Whether pubescent or glabrous, however, all of the plants within the range of subspecies *austrofloridense* exhibit characters at the micromorphological level that distinguish them from plants outside this range. It turns out that the two subspecies are most reliably distinguishable by differences in epidermal and cuticular patterns of the abaxial leaf surface (Table 1). These features are visible with good lighting using a high-quality dissecting microscope (such as the Wild M5A) at 1000×, but scanning electron microscopy reveals these features in dramatic clarity. In subspecies *austrofloridense* (Fig. 4), the cuticular features are of moderate to strong relief, and the surface between stomata is elaborately ornamented with a reticulating pattern of grooves and ridges. Epidermal cell outlines are always prominently visible and marked by an impressed groove or by a ridge with a groove within it (See arrows, Fig. 4). In subspecies *reclinatum*, by comparison (Fig. 5), the cuticular ornamentations are of low to moderate relief, and the surface between stomata is relatively smooth and irregularly undulating. Epidermal cell outlines, if visible, are marked by raised ridges that lack an impressed groove along their middle (See arrows, Fig. 5). Thus at the micromorphological level it is easy to distinguish the two subspecies.

KEY TO SPECIES OF THE *SIDEROXYLON RECLINATUM* COMPLEX

1. Plants highly stoloniferous, often forming clonal patches, aerial shoots rarely more than 1 m tall; fruit 10–14 mm long, plant of dry sandy habitats.
   2. Pubescence on young twigs dense, rusty dark red-brown, often persisting well past the first season; abaxial pubescence

Fig. 3. (A–B): Ovary, A: *Sideroxylon reclinatum* subsp. *reclinatum*; B: *S. reclinatum* subsp. *austrofloridense*. (C–D): Flowering twig; C: *S. reclinatum* subsp. *reclinatum*; D: *S. reclinatum* subsp. *austrofloridense*. E–H: *S. reclinatum* subsp. *austrofloridense*, Long Pine Key, Everglades National Park, E: Shrub in marl prairie, ca. 1.5 m tall (pine rockland in background); (F) Flowering branch; (G) Fruiting branch; (H) Older branch, ca. 3 cm diameter, with leaves and flowers on brachyblasts.

on young leaves rusty red-brown, sparse to moderately dense, giving surface a distinctly reddish hue; staminodes nearly as long as median corolla lobes; ovary densely pubescent; seed variegated; stomatal chamber openings located on raised, round, donut- shaped platforms _____ **S. rufohirtum**

2. Pubescence on young twigs moderate to dense, blonde to light brown, rarely persisting past the first season; abaxial pubescence on young leaves blonde to light brown, sparse; staminodes only ½ to ⅔ the length of median corolla lobes; ovary glabrous or with a few trichomes medially; seed uniformly brown; stomatal chamber openings atop raised elliptical domes neatly bordered by one or more concentric ridges _____ **S. macrocarpum**

1. Plants not highly stoloniferous, growing as erect shrubs with one to several stems, or occasionally small trees, often taller than 1 m; fruit 7–10 mm long, plant of mesic to wet habitats _____ **S. reclinatum**

Delimitation of the subspecies of Sideroxylon reclinatum.—It can be seen that *Sideroxylon reclinatum* subsp. *austrofloridense* is easily and reliably diagnosable from *S. reclinatum* subsp. *reclinatum* by a set of distinct character state differences at the micromorphological level. At the macromorphological level, the distinction is less reliable, as glabrescent specimens of subspecies *austrofloridense* can be confused with the typically glabrous subspecies *reclinatum*. The two taxa are also separated eco-geographically. The more widespread subspecies *reclinatum* ranges in coastal plain areas from south Georgia west to Louisiana, and throughout Florida as far south as Broward County in the east, and Collier and Monroe Counties in the west, and its habitats feature sandy soils often with limestone near the surface. Subspecies *austrofloridense*, on the other hand, is a narrow endemic, its range restricted to subtropical rockland and marl prairie habitats in a well-defined area of extreme southeast peninsular Florida, and its habitats feature exposed limestone, or limestone thinly overlain with clayey marl soils. All specimens we examined that were collected within the range of subspecies *austrofloridense*, whether glabrous or pubescent, exhibit the unique micromorphological cuticular surface characters described above (Figs. 4, 5). The only place where plants of both micromorphological types occur together is

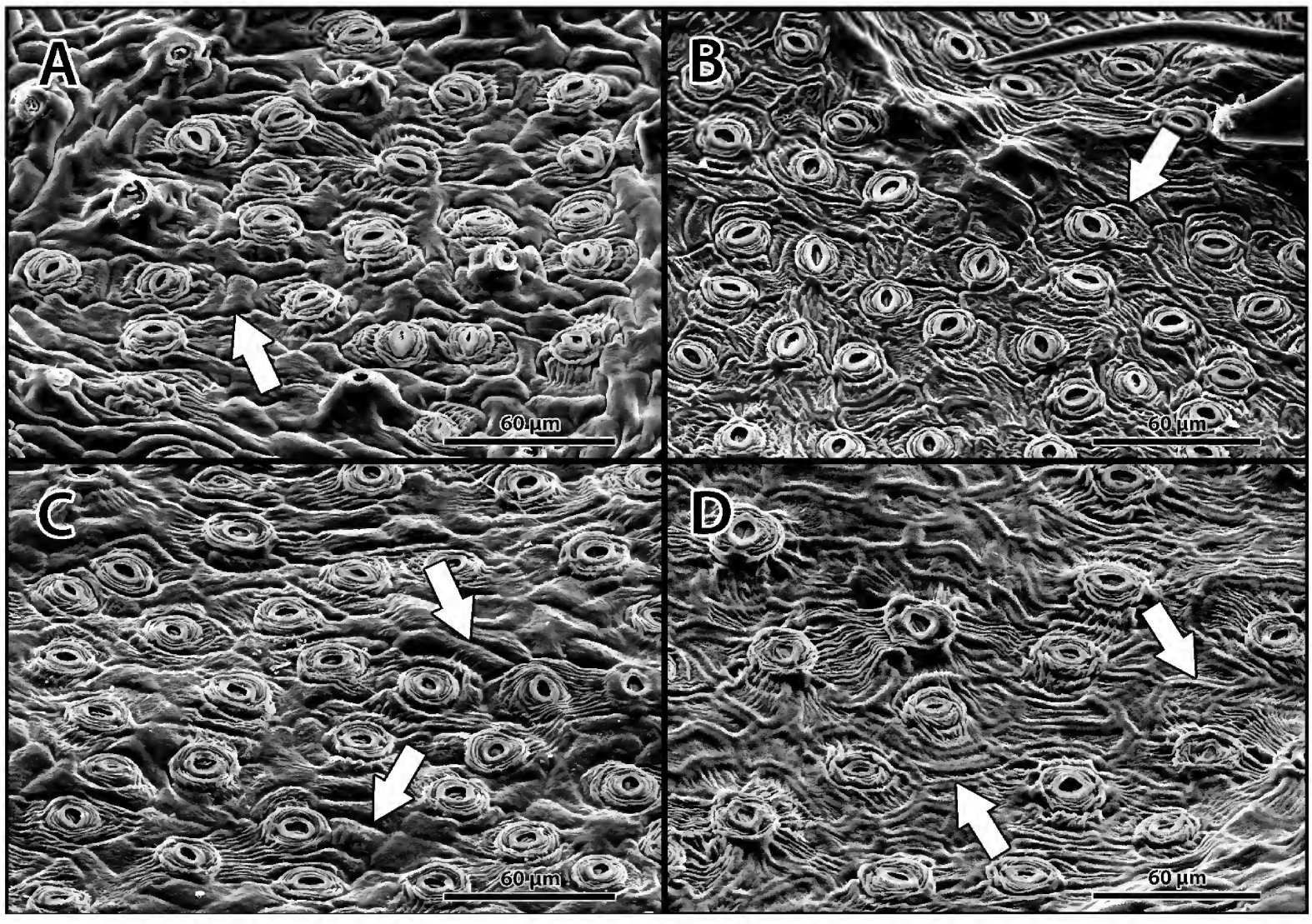


Fig. 4. SEM images of abaxial leaf surface of four different individuals of *Sideroxylon reclinatum* subsp. *austrofloridense*. A: *Corogin 1055* (FNPS), Long Pine Key, Everglades National Park; B: *Possley 67* (FTG), urban Miami-Dade County, FL, Larry & Penny Thompson Park; C: *Bradley 1547* (FTG), Collier County, FL, near Monument Lake, Big Cypress National Preserve; D: *V.I. Sullivan s.n.* (FTG), Long Pine Key, Everglades National Park. Note that epidermal cell outlines are defined in all cases by an impressed groove or a ridge with an impressed groove within it (see arrows). (Magnification 500×).

where the ranges of the two subspecies come into contact, at the western fringes of the range of subspecies *austrofloridense*, in Big Cypress National Preserve (Fig. 6). The two subspecies are thus clearly defined, and essentially allopatric. Because *S. reclinatum* subsp. *austrofloridense* is a narrow endemic restricted to a particular habitat and geographical area, and because it is allopatric with respect to subspecies *reclinatum* and diagnosable from it, we consider *Sideroxylon. reclinatum* subsp. *austrofloridense* to be worthy of taxonomic recognition. Since the diagnosing characters are micromorphological and somewhat cryptic, and pubescence characters intergrade, we consider recognition at the subspecific rank to be appropriate. Thus the current classification of these plants is maintained, but the distribution of subspecies *austrofloridense* is broadened, and it is best diagnosed by the newly discovered micromorphological features.

KEY TO THE SUBSPECIES OF *SIDEROXYLON RECLINATUM*

1. Young twigs and leaves glabrous or sparsely pubescent with quickly deciduous, fine, blonde to light brown trichomes; mature leaves glabrous or with a few blonde to light brown trichomes persisting along midvein; sepals, pedicels and ovary glabrous or with very few pale trichomes; *abaxial leaf epidermal cell outlines obscure, or if visible, defined by raised ridges that lack an impressed groove along their middle.* _____ **S. reclinatum** subsp. **reclinatum**
1. Young twigs and leaves densely to sparsely pubescent with brown, finely wooly trichomes; mature leaves glabrous to densely pubescent across abaxial lamina with finely wooly, matted, brown to grey indumentum; sepals, pedicels, and ovary glabrous to densely pubescent with brown trichomes; *abaxial epidermal cell outlines always clearly visible, strikingly defined by impressed grooves, or raised ridges with impressed grooves along their middle* _____ **S. reclinatum** subsp. **austrofloridense**

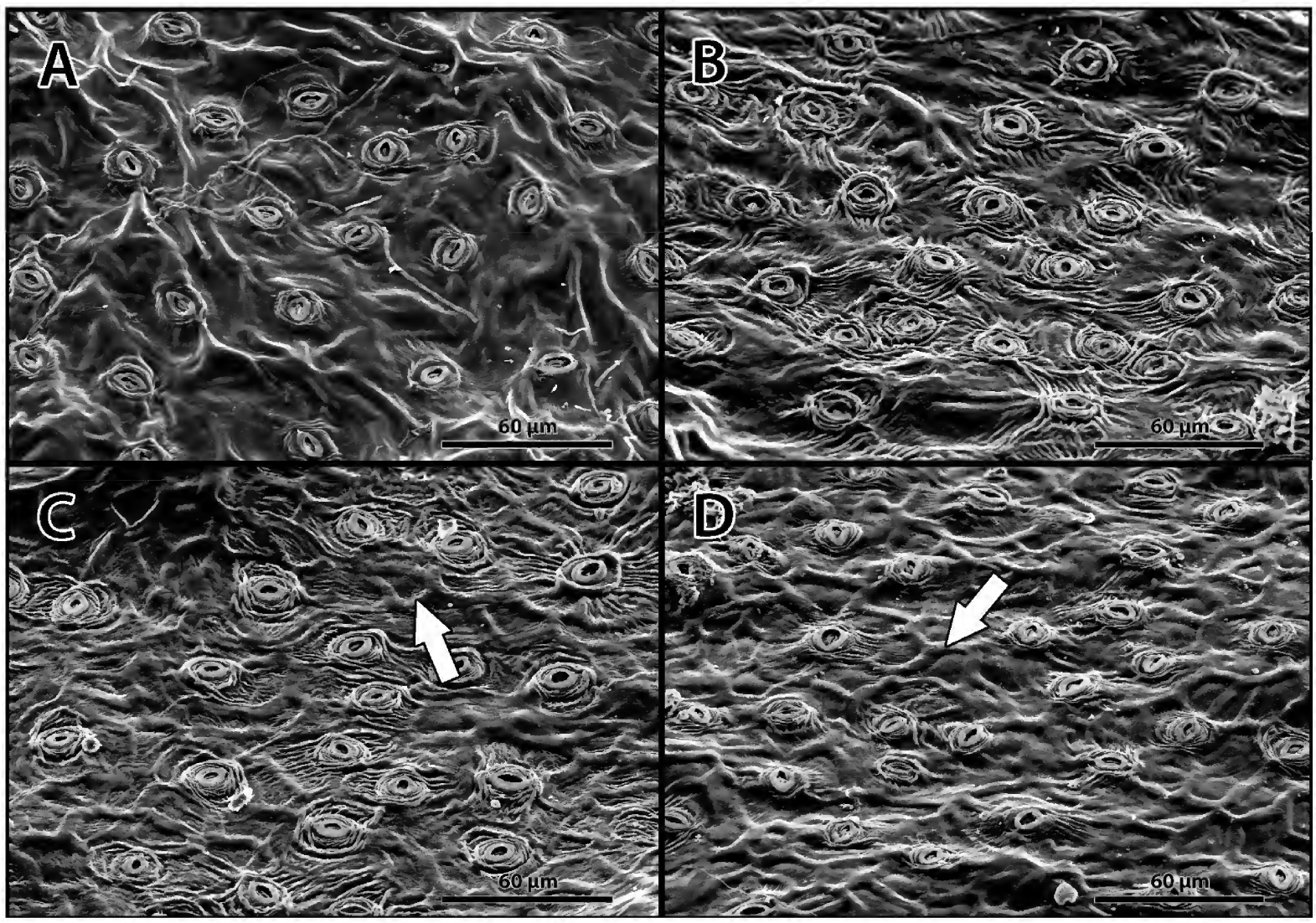


Fig. 5. SEM images of abaxial leaf surface of four different individuals of *Sideroxylon reclinatum* subsp. *reclinatum*. A: *Corogin 1060* (FLAS), Gilchrist County, FL; B: *Godfrey 81312* (FLAS), Taylor County, FL; C: *Correll 42244* (FTG), Monroe County, FL, at Pine Crest in Big Cypress National Preserve; D: *Godfrey 81581* (FTG), Columbia County, FL. Note that epidermal cell outlines, if visible at all, are defined by raised ridges without the presence of an impressed groove (see arrows). (Magnification 500×).

TAXONOMIC TREATMENT

Sideroxylon reclinatum Michx. subsp. **austrofloridense** (Whetstone) Kartesz & Gandhi, Phytologia 68:425. 1990. *Bumelia reclinata* (Michx.) Vent. var. *austrofloridensis* Whetstone, Ann. Missouri Bot. Gard. 72:545. 1985. TYPE: U.S.A. Florida. Dade Co.: Everglades National Park, 7 July 1984, *R.D. Whetstone 14459* (HOLOTYPE: JSU).

Shrub, single to many-stemmed, occasionally a small tree, ca. 0.5–3.5 m tall, trunk diameter ca. 1–7 cm. Indumentum of unicellular, light brown to grey-white, occasionally red-brown, T-shaped trichomes, symmetric or asymmetric, terete and hollow to flattened in cross-section, having a short stalk and a longer upper portion of varying length, the upper portion curled and ascending. Vegetative buds densely wooly-pubescent with short, curled, ascending, red-brown T-shaped trichomes, the stalk 0.025–0.06 mm, the upper portion 0.2–0.6 mm. Young twigs (long shoots) terete, sparsely lanulose to glabrate, quickly becoming glabrous, smooth, red-brown, prominently dotted with lenticels; thorns often present at nodes, especially on young stems, 3–20 mm long, some becoming short spur shoots or lengthening to become side branches. Mature twigs glabrous, the smooth outer surface becoming longitudinally fissured and fading to very light grey by the second season, becoming rough and gnarled in subsequent seasons, transverse fissures appearing along with deepening longitudinal fissures, giving bark of older stems a somewhat rectangularly-plated reticulate appearance, the leaves clustered on stumpy brachyblasts (short shoots), internode length 7–33 mm. Leaves with petiole 4–5 mm long on young long shoots, 2–4 mm on short shoots, the petioles glabrous or sometimes with a wooly indumentum, light brown and moderately dense to sparse on young petioles, becoming grey-white and sparse on older petioles; blade 29–50 mm long, 16–21 mm wide, rhombic to elliptic to obovate on young long shoots, 8–52 mm

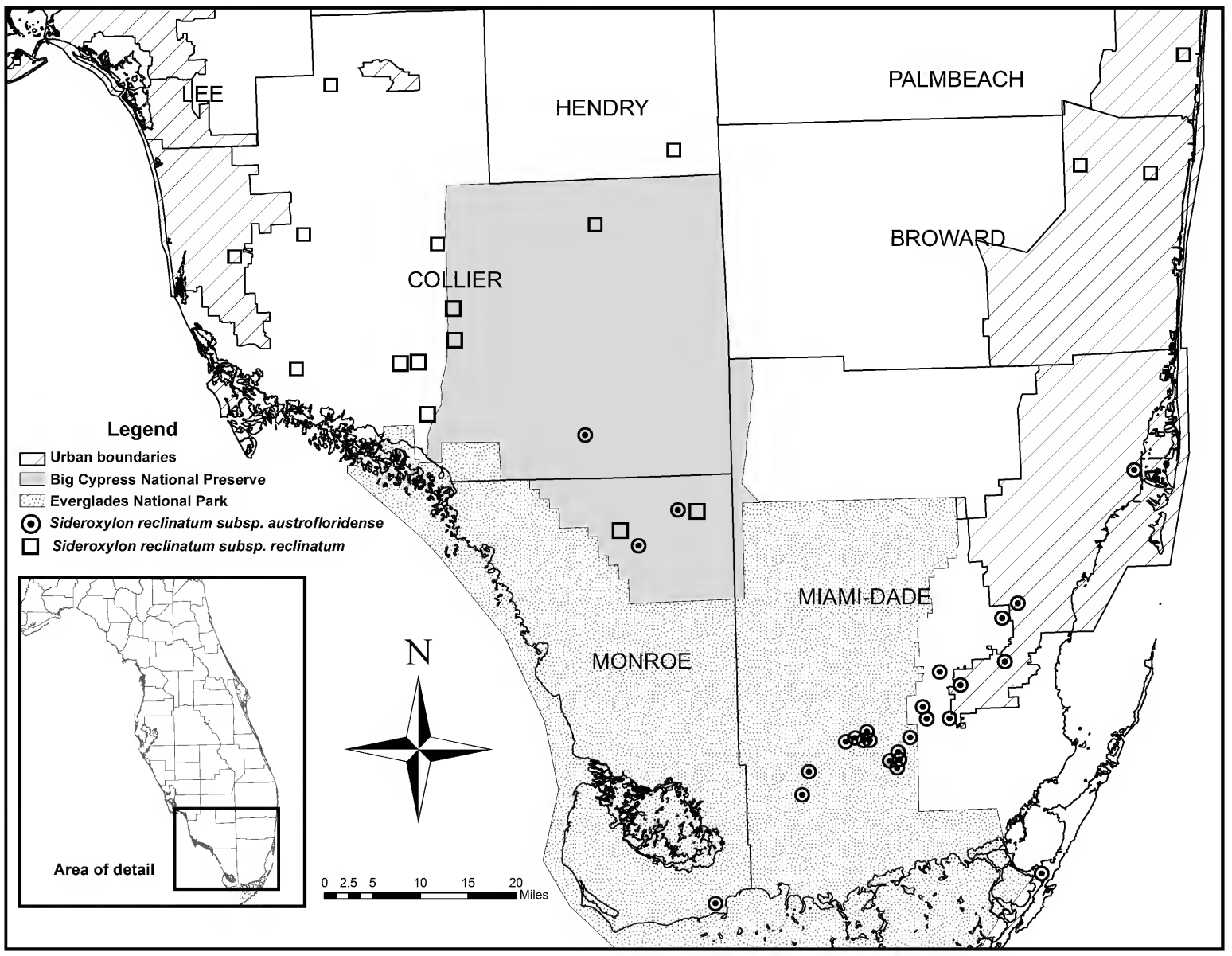


Fig. 6. Distribution of *Sideroxylon reclinatum* subsp. *austrofloridense* (circled dots) and *S. reclinatum* subsp. *reclinatum* (squares). The range of *S. reclinatum* subsp. *austrofloridense* is centered on the Miami rock ridge, with outliers historically as far south as Key Largo and Flamingo, and more recently as far west and north as Big Cypress National Preserve. Map shows vouchered occurrences only.

long, 5–19 mm wide, narrowly obovate to elliptic (on short shoots), coriaceous, the apex rounded to emarginate, the base cuneate to acute, the margin entire, blades of mature leaves often markedly involute; venation pinnate and conspicuously finely reticulate, brochidodromous, with secondary veins slightly decurrent, branching off midvein in opposite to alternate arrangement, more or less in 6–10 irregularly spaced pairs, with an intersecondary vein occasionally occurring between secondaries, the tertiary and quaternary veins irregular-reticulate, the quinternary veins irregular-reticulate to freely ramifying, areolation moderately developed, the marginal ultimate venation looped; adaxial surface dark green, semi-glossy, sparsely pubescent when young with fine trichomes, becoming glabrous, the veins impressed (fresh leaf) to conspicuously raised (dried leaf), giving the surface a finely textured appearance; abaxial surface glabrous or often sparsely to densely covered with a variably persistent finely wooly indumentum, on young leaves light brown, sparse to moderately dense and matted, often at least partially obscuring the leaf surface, on older leaves fading to grey-white and becoming less dense to glabrate, the trichomes T-shaped, with stalk 0.02–0.08 mm long, upper portion 0.3–1.5 mm long, the upper portions mostly curled and ascending, abaxial epidermal cell boundaries evident under high magnification and marked by impressed grooves, the veins flush to slightly raised (fresh leaf) to raised (dried leaf). Inflorescence a fascicle borne in a leaf axil, these often clustered on short shoots in axils of fallen leaves, each cluster having 3–30 pedicellate flowers, the pedicels 2.5–11.8 mm long, glabrous to densely wooly-strigose at anthesis, often becoming glabrous in fruit. Calyx of 5 (–6) quincuncial, free sepals, the outer two sepals 1.8–2.0 mm long, 1.5–1.7 mm wide, ovate to suborbicular, the apex rounded, the margin entire,

opaque, the inner three sepals 1.8–2.2 mm long, 1.7–2.4 mm wide, orbicular, the apex rounded, the margin entire to erose with broad zone of thin translucent tissue, all sepals glabrous to moderately densely pubescent with light brown to red-brown T-shaped trichomes, the pubescence, if present, wooly on the outer, sericeous on the inner. Corolla white, cyathiform, sympetalous, the tube 1.5–1.8 mm long, enclosed within the calyx, the lobes 5 (–6), exserted and spreading, glabrous, each with a median lobe and two lateral segments, the median lobe 1.5–2.0 mm long, 1.5–2.0 mm wide, orbicular, clawed, cupped around a stamen, the lateral segments 1.8–2.2 mm long (from junction with tube), 1.5–1.8 mm long (from junction with median lobe), 0.7–1.0 mm wide, lanceolate, margins erose, translucent. Stamens 5 (–6), epipetalous, opposite the corolla lobes, exserted; filament 1.4–1.8 mm long, 0.4 mm wide, fixed at top of corolla tube, dilated proximally and narrowing toward anther attachment; anther 1.0–1.1 mm long, sagittate, ventrifixed at the point of the sinus, extrorse, opening by two longitudinal slits. Staminodes petaloid, alternating with stamens, each staminode 2.2 mm long, 1.5 mm wide, deltoid to ovate, margin erose, translucent. Ovary superior, 5–(6–) loculate, locules uniovulate with basal-axile placentation, ovary ca. 1.0–1.3 mm long, 1.0 mm wide, globose to ovoid, tapering abruptly to 1 mm-long style, the ovary at anthesis glabrous to densely pubescent with a sericeous indumentum of straight, appressed, white to slightly tawny T–shaped trichomes, the trichomes longer on distal part of ovary. Fruit a berry, one (rarely 2) - seeded, 6.3–11.0 mm long, 6–10 mm wide, ellipsoid to slightly obovoid to subglobose, black, glossy, glabrous, borne on pedicels 2.5–11.8 mm long. Seeds 4.2–7.0 mm long, 3.6–6.0 mm wide, subglobose to ellipsoid, the testa hard, smooth, glossy, dark to light brown, the color solid to boldly mottled; the hilum scar basal, usually bipartite, the larger part basal, oval to half-moon shaped, 0.8–2.2 mm long, 1.2–2.8 mm wide, with a smaller, laterally elongate part abaxial to the other part, 0.8–2.8 mm long, 0.2–1.2 mm wide, the two parts well-separated by a bridge of testa, the scar being the exposed portion of a hollow cavity under the testa extending a small distance around the basal end of the seed, the cavity filled, especially on the abaxial side, with a yellowish fatty substance.

Distribution and habitat.—*Sideroxylon reclinatum* subsp. *austrofloridense* is found only in Miami-Dade, Monroe, and Collier Counties, Florida, where it is restricted to pine rocklands, marl prairies, and edges of tropical rockland hardwood hammocks (Fig. 6). The range of this taxon is centered in Miami-Dade County on the Miami rock ridge, which extends from Long Pine Key in the Everglades northward through urban Miami to the Miami River. It is locally abundant at Long Pine Key, and is found at Pine Island, and around the edges of Royal Palm Hammock and Paradise Key, in Everglades National Park. It has been collected in several extant rockland fragments in the urbanized areas of the Miami rock ridge as far north as the Miami City Cemetery (1944, *A. Korsakoff s.n.*). Historically, it was collected as far south as Key Largo (1948, *C.R. Jackson s.n.*) and Flamingo (1924, *J.K. Small 11537*) in Monroe County. More recently it has been collected farther west and north at locations in Big Cypress National Preserve: Monument Lake in Collier County (2014, *Sadle 630;* 1998, *Bradley 1547*), and the Loop Road area (1964, *Godfrey 63520*) and Lostman's Pines area (2003, *Woodmansee 1121*) in Monroe County (Hodges & Bradley 2006; Gann et al. 2014). There are unvouchered reports of additional occurrences on the Miami rock ridge and in Big Cypress National Preserve (Gann et al. 2014). All locations where *Sideroxylon reclinatum* subsp. *austrofloridense* has been collected have limestone bedrock either exposed at the surface or covered with only a thin layer of marl-based soil. These soils become more sandy toward the northwestern limits of the range, where *S. reclinatum* subsp. *reclinatum* is also found.

Phenology.—Flowering April–May, fruit ripening in June–July.

Additional specimens examined: **USA. Florida. Collier Co.:** Big Cypress National Preserve, Monument Lake Campground, 22 Mar 1998, *Bradley 1547* (FTG); Big Cypress National Preserve, Monument Lake Campground, marl prairie E of rd. to campground and N of radio tower service rd., UTM 17N 488611E, 2860886N, 29 May 2014, *Sadle 630* (FNPS). **Miami-Dade Co.:** Everglades National Park, Long Pine Key, 2.5 mi W of campground T5,7S, R37E, SW¼ Sec 32, 11 May 1999, *Anderson 18620* (FSU); Everglades National Park, Long Pine Key near Mosier Hammock, 11 May 1999, *Anderson 18621, 18622* (FSU); Everglades National Park, bordering Pine Island Rd., 0.3 mi S of main road, T58S, R37E, SW¼ Sec 12, 11 May 1999, *Anderson 18623* (FSU); Frog Pond, just W of C-111 canal, 3.5 miles N of Rt 27, ca. 4 mi W of Florida City, 11 May 1999, *Anderson 18625*, (FSU); Lucille Hammock, 0.9 mi W of 217th Ave., ca. 3 mi W of Florida City, T57S, R38E, SW¼ Sec. 29, 11 May 1999, *Anderson 18629* (FSU); Pine Ridge Sanctuary, 21100.SW 300 St., ca. 2 air mi NW of Homestead, 11 May 1999, *Anderson 18631* (FSU); Everglades National Park, Long Pine Key, May 1908, *E.A. Bessey 75* (A); Everglades, Paradise Key, 5 May 1908, *E.A. Bessey 2* (G); Frog Pond, 25°26.837'N, 080°33.757'W, 6 Aug 1997, *Bradley & Woodmansee 422* (FTG); NW of Royal Palm Park, 3 May 1938, *Buswell s.n.* (FTG);

Everglades National Park, Long Pine Key, N and W of campground, 26 Jul 2011, 25.40341°N, 080.65797°W, *Corogin 1045* (FNPS); ibid., 25.40335°N, 080.65838°W, *Corogin 1046* (FNPS); ibid., 25.40244°N, 080.66216°W, *Corogin 1047* (FNPS); ibid., 25.40138°N, 080.66822°W, *Corogin 1048* (FNPS); ibid., 25.40172°N, 080.66997°W, *Corogin 1049* (FNPS); ibid., 27 Jul 2011, 25.40463°N, 080.67649°W, *Corogin 1050* (FNPS); ibid., 25.40342°N, 080.67348°W, *Corogin 1051* (FNPS); ibid., 28 Jul 2011, 25.40359°N, 080.66031°W, *Corogin 1052* (FNPS); ibid., 25.40442°N, 080.65965°W, *Corogin 1053* (FNPS); ibid., 25.40061°N, 080.66123°W, *Corogin 1054* (FNPS); ibid., 25,40061°N, 080.66103°W, *Corogin 1055* (FNPS); ibid., 25.40096°N, 080.66393°W, *Corogin 1056* (FNPS); ibid., 11 May 2013, 25°24'5.6"N, 080°39'35.9"W, *Corogin 1273* (FNPS); ibid., 25°24'6.2"N, 080°39'38"W, *Corogin 1274* (FNPS); ibid., 25°24'7.4"N, 080°39'42.9"W, *Corogin 1275* (FNPS); ibid., 25°24'6.2"N, 080°40'11.9"W, *Corogin 1276* (FNPS); ibid., 26 Jul 2013, 25°24'6.2"N, 080°40'11.9"W, *Corogin 1286* (FNPS); Everglades National Park, Long Pine Key, 9 Jul 1961, *Craighead s.n.* (USF); Everglades National Park, Long Pine Key near Redd Hammock, 22 Dec 1958, *Craighead s.n.* (FLAS); West Avocado Drive, 15 Feb 1955, *F.C.C. 352* (FTG); near Naranja, 21 Jan 1937, *Fennell 301* (A); Everglades National Park, Royal Palm Hammock, 6 May 1928, *Fisher 54* (US); Everglades National Park, Long Pine Key, 18 Apr 1964, *Godfrey 63460* (FSU); Everglades National Park, 3.2 mi N of Rock Reef Pass, 17 Apr 1964, *Godfrey 63394* (FSU); Everglades National Park, Long Pine Key, 4 May 1979, *Godfrey 77025* (FSU); Everglades, N end Paradise Key, 29 Mar 1909, *R.M. Harper 110* (G); Everglades National Park, pinelands auto trail,1.5 mi W of Long Pine Key rd., 21 Jun 1975, *Hill & Harvey 3215* (FTG); Miami City Cemetery, 30 Mar 1944, *Korsakoff s.n.* (FLAS); Larry & Penny Thompson Park, 25.59887°N, 080.40135°W, 26 May 2004, *Possley 67* (FTG); Quail Roost Pineland, 25.57630°N, 080.42754°W, 26 Apr 2011, *Possley 109* (FTG); Sunny Palms Pineland, 25.42835°N, 080.52053°W, 26 May 2011, *Possley 110* (FTG); Everglades National Park, Paradise Key, 3 May 1920, *Rehder 898* (A); Everglades National Park, marl prairie near edge of Royal Palm Road, N of Royal Palm Hammock, UTM 17N 538844E, 2808076N, 28 May 2014, *Sadle 627, 628* (FNPS); Everglades National Park, marl prairie adjacent to wet pine rocklands at western edge of Pine Island, just N of Main Park Rd., UTM 17N 541041E, 2808752N, 28 May 2014, *Sadle 629* (FNPS); Everglades National Park, Royal Palm Hammock/Paradise Key and vicinity, 21 Sep 1917, *Safford & Mosier 22* (US); Everglades, S of Long Key, 18 Jan 1909, *J.K. Small & J.J. Carter s.n.* (FTG); Hammocks, Homestead to Big Hammock Prairie, 15 Feb 1911, *J.K. Small & J.J. Carter s.n.* (FTG); Everglades, Camp Jackson to Camp Longview, 21 Feb 1911, *J.K. Small & J.J. Carter s.n.* (FTG); Everglades National Park, Long Pine Key, 6 May 1904, *J.K. Small & P. Wilson s.n.* (US); Everglades National Park, Long Pine Key, 5 Apr 1968, *Sullivan s.n.* (FTG); Everglades National Park, Long Pine Key near picnic ground, 8 Apr 1971, *Tomlinson & Avery s.n.* (FTG); Everglades National Park, 4.6 mi S of park entrance on main rd. to Flamingo, 23 Apr 1958, *Traverse 592* (G); Everglades, Long Pine Key, 5 Jul 1950, *Woodbury s.n.* (FTG). **Monroe Co.:** Near Fla. Rt 94, 3.8 mi W of Dade-Monroe County line, 19 Apr 1964, *Godfrey 63520* (FSU); Key Largo, 27 Feb 1948, *Jackson s.n.* (FTG); Hammock back of Flamingo, Cape Sable region, 21 Jul 1924, *J.K. Small et al. s.n.*(G); Big Cypress National Preserve, Lostmans Pines area, ca. 11.13 km S of Loop Rd. (State Rt 94), 17.9 km W of the Miami-Dade County line, just N of border with Everglades National Park, 25.66063° N, 081.04996° W, 26 Mar 2003, *Woodmansee 1121* (FNPS).

Endemism in South Florida rockland habitats.—The southern tip of peninsular Florida, including the Florida Keys, is one of the state's hotspots of rare and endemic plant taxa (Ward 1979; Chaplin et al. 2000). Unusual for the continental United States, the flora of this region is dominated by tropical species of West Indian origin. The uniqueness of *Sideroxylon reclinatum* subsp. *austrofloridense* is enhanced by the fact that it is narrowly endemic to the pyrogenic pine rockland habitat of this area. Featuring an overstory of south Florida slash pine (*Pinus elliottii* Engelm. var. *densa* Little & Dorman), these rocklands, dotted with small tropical hardwood hammocks and surrounded by marl prairies and marshes, thrive on exposed karstic limestone bedrock only partially covered with the thinnest of soils, at an elevation of only 1–5 m above sea level (Snyder et al. 1990). The understory features a diverse mix of tropical and temperate shrubs, palms, and herbs, with a large number of endemic taxa present in the species-rich herbaceous layer (Loope & Avery 1979; Avery & Loope 1980; Olmsted et al. 1983; Snyder et al. 1990). South Florida pine rocklands share functional, structural, and floristic similarities with tropical rocklands of the Bahamas, Cuba, Hispaniola, and Central America, which are also pyrogenic communities on exposed limestone with a pine overstory, highly diverse understories, and high endemism (Judd 1987; O'Brien et al. 2008; Myers & Rodriguez-Trejo 2009). Although pine rocklands exist in the lower Florida keys, *Sideroxylon reclinatum* subsp. *austrofloridense* has never been collected there (Hodges & Bradley 2006). Its known current range is limited to extant rocklands on the mainland, although an early collection from northern Key Largo exists (1948, *C.R. Jackson s.n.*, Fig. 6).

Around thirty plant taxa endemic to south Florida are found in pine rocklands; around a dozen of these are restricted to pine rockland (Avery & Loope 1980; Snyder et al. 1990; Bradley & Gann 1999; FNAI 2010; Gann et al. 2014). Many of these endemics are listed as endangered or threatened at the state or federal level, and several are candidates for listing (Gann et al. 2014). Endemic associates of *Sideroxylon reclinatum* subsp. *austrofloridense* at Long Pine Key include *Chamaesyce deltoidea* (Engelm. ex Chapm.) Small subsp. *pinetorum* (Small) A. Herndon, *C. porteriana* Small, *Euphorbia pinetorum* (Small) G.L. Webster, *Jacquemontia curtisii* Peter ex Small, *Lantana depressa* Small var. *depressa* (Sanders 1987), *Melanthera parvifolia* Small, *Phyllanthus pen-*

taphyllus C. Wright ex Griseb. var. *floridanus* G.L. Webster, *Schizachyrium rhizomatum* (Swallen) Gould, and *Tragia saxicola* Small.

The shrub layer of pine rocklands features more than ninety taxa, mostly of West Indian affinity (Olmsted et al. 1983). Woody associates of *Sideroxylon reclinatum* subsp. *austrofloridense* at Long Pine Key include two species of *Sideroxylon*, *S. celastrinum* (Kunth) T.D.Penn. and *S. salicifolium* (L.) Lam; both are tropical, ranging from southern Florida into the Caribbean, Mexico, and Central America. *Sideroxylon reclinatum* subsp. *reclinatum* has not been collected in Everglades National Park, but it has been collected in Monroe County at Big Cypress National Preserve (Gann et al. 2014), where the ranges of the two subspecies come into contact.

Other woody understory associates include *Ardisia escallonioides* Schiede & Deppe ex Schltdl. & Cham., *Bourreria cassinifolia* (A.Rich.) Griseb., *Byrsonima lucida* (Mill.) DC., *Chiococca alba* (L.) A.S. Hitchc., *Chrysobalanus icaco* L., *Chrysophyllum oliviforme* L., *Coccothrinax argentata* (Jacq.) L.H. Bailey, *Conocarpus erectus* L., *Croton linearis* Jacq., *Dodonaea viscosa* Jacq., *Forestiera segregata* (Jacq.) Krug & Urb., *Guapira discolor* (Spreng.) Little, *Guettarda elliptica* Sw., *G. scabra* (L.) Vent., *Ilex cassine* L., *Metopium toxiferum* (L.) Krug & Urb., *Morinda royoc* L., *Mosiera longipes* (O. Berg) Small, *Myrica cerifera* L., *Myrsine cubana* A. DC., *Randia aculeata* L., *Rhus copallinum* L., *Tetrazygia bicolor* (Mill.) Cogn., and *Vachellia farnesiana* (L.)Wright & Arn. var. *pinetorum* (F.J.Herm.) Seigler & Ebinger.

Conservation status.—*Sideroxylon reclinatum* subsp. *austrofloridense* is a candidate for federal listing under the Endangered Species Act, under the common name "Everglades Bully" (USFWS 2013a). Although the main population of *S. reclinatum* subsp. *austrofloridense* is locally abundant and located on protected land, the U.S. Fish and Wildlife Service considers that a change in listing status is warranted but precluded by higher priorities (USFWS 2013b; Sadle, pers. comm.). The Institute for Regional Conservation in Miami considers *Sideroxylon reclinatum* subsp. *austrofloridense* to be imperiled in south Florida (Gann et al. 2002, 2014). The pine rockland plant community is ranked critically imperiled both globally and in Florida by the Florida Natural Areas Inventory (FNAI 2010). The pine rocklands of mainland south Florida once extended from Long Pine Key, the principal upland of Everglades National Park, northeastward along the Miami rock ridge as far as the Miami River, but urban and agricultural development has extirpated the native plant cover from all but Long Pine Key and a handful of small patches on private land or preserved as county parks (Olmsted et al. 1983; Bradley & Martin 2012). The chief immediate threats to *Sideroxylon reclinatum* subsp. *austrofloridense* and its habitat are fire suppression and exotic species invasion. Recommended conservation actions currently consist of habitat protection and maintenance by prescribed fire, control of invasive non-native species, efforts to acquire, monitor and protect remaining rockland fragments, and continued monitoring and study to watch for adverse effects that may arise from human activities such as water management policies and the Everglades restoration program (Gann et al. 2002; FNAI 2010; USFWS 2013b).

Long-term sea level rise due to climate change also threatens the rockland flora. Discovery of 8600-year-old submerged remains of pine trees 60 km west of Key West suggests that since the last glacial maximum (ca. 18,000 years before present), south Florida pinelands have been in retreat as rising seas have inundated a once more extensive range; during the past century that retreat has continued measurably in the Florida keys (Ross et al. 1994, 2009). As sea level rises, outright inundation is preceded by saltwater intrusion, which is currently producing changes to the species composition of vulnerable south Florida coastal habitats (Saha et al. 2011). Sea level is predicted to rise 1–2 m by 2100 (URS Corporation et al. 2007; Saha et al. 2011), and elevation at Long Pine Key is 2 m or less. *Sideroxylon reclinatum* subsp. *austrofloridense* and its rare and endemic associates clearly face an uncertain future.

APPENDIX

Additional specimens examined for SEM study, and for the south Florida distribution map (Fig. 6). Additional specimens of these taxa from their entire range were also examined and will be cited in an upcoming taxonomic revision.

Sideroxylon reclinatum Michx subsp. **reclinatum.—USA. Florida. Broward Co.:** Cypress Creek Hammock near Margate, 28 Apr 1977, *Correll 48485* (FTG); Fern Forest Nature Center, Coconut Creek, T59S, R42E, Secs. ⅝, 8 May 2001, *Howell 389* (USF). **Collier Co.:** 2 mi E of Collier-Seminole State Park, by US 41, 1 May 1979, *Godfrey 77002* (FSU); Cross State Turnpike, Miles City, W of FL 29, 27 May 1966, *Lakela & DeBoer 29857* (USF); Deep Lake, 3 mi N of Jerome, 1 mi E of FL 29, 21 Aug 1965, *Lakela & Laker 29124* (USF); Fakahatchee

Strand State Preserve, 0.3 mi N of Gate 1, W of James Scenic Drive, 22 May 1999, *Pires FS0356* (USF); Fakahatchee, margin of hammock, 6 Mar 1965, *Lakela & Long 28181* (USF); off rd. to Bird Sanctuary, Corkscrew, 7 Mar 1965, *Lakela & Long 28215* (USF); Kissimmee Billy, N of Alligator Alley, 28 Apr 1976, *Correll 47094* (FTG). **Flagler Co.:** N side of Fla. 305, 5.7 mi E of Volusia Co. line, S32, T13S, R29E, 7 Jul 1965, *Ward 4725* (FLAS). **Gadsden Co.:** Banks of Apalachicola River at Aspalaga, 7 Jul 1955, *Godfrey 53598* (G); by County Rd. 269, 0.5 mi from railroad crossing at River Junction, 1 Jul 1991, *Godfrey 84198* (TENN); Chattahoochee, bluff along Apalachicola River overlooking Clyde T. Hopkins Municipal Park on River Landing Rd., 8 May 1995, *MacDonald 8652* (TENN). **Gilchrist Co.:** Banks of Suwannee River, near public boat ramp W of Otter Springs, 5 Jun 2012, *Corogin 1060* (FLAS); NW of Trenton, ca. 1 mi W of dead-end of County Rd. 344, at Suwannee River, ca. 0.5 mi W of Hart Springs Park, 6 Sep 2003, *Judd 8047* (FTG). **Hendry Co.:** Big Cypress Reservation, 8 May 1959, *Sturtevant 146* (US). **Lee Co.:** Fort Myers, 26 Apr 1934, *Buswell s.n.* (FTG). **Monroe Co.:** Big Cypress National Preserve, near Pine Crest, along Loop Rd. 94, 28 Apr 1974, *Correll 42244* (FTG). **Palm Beach Co.:** Yamato Scrub Natural Area, ca. 0.25 mi E of Congress Ave., N of Clint Moore Rd., 26°24.58'N, 80°05.944'W, 12 May 1998, *Bradley & Woodmansee 977* (FTG). **Taylor Co.:** Near Steinhatchee River, by US Rt 98/19, NW of Cross City, 19 May 1984, *Godfrey 81312* (FLAS).

Sideroxylon macrocarpum (Nutt.) J.R. Allison.—**USA. Georgia. Jeff Davis Co:** powerline right of way immediately W of Appling Co. line and 0.6 mi from Perry Miller Rd., 31°52.85'N, 82°26.75'W, 26 May 1999, *Nelson 20576* (GA). **Laurens Co.:** ca. 19.2 air mi SE of Dublin, ca. 9.2 air mi ENE of Cedar Grove, W side of GA Hwy 19, ca. 0.3 road mi S of Buck Creek, 21 Aug 1996, *Allison 9404* (FSU). **Pierce Co.:** ca. 2 mi NE of Blackshear, N of Shiloh Church, 29 Sep 1999, *Allison 12228* (GA). **Tattnall Co.:** Gordonia Altamaha State Park, along rd. S of golf course, 32°05'08"N, 082°08'03.8"W, 24 Sep 2012, *Corogin 1179* (FLAS). **Wheeler Co.:** ca. 11.3 linear mi NNE of Alamo, S side Oconee River, ¼ mi E of GA Hwy 46, 26 Jul 1996, *Allison 9356* (GA).

Sideroxylon rufohirtum Herring & Judd.—**USA. Florida. Alachua Co.:** Near Kanapaha Prairie southwest of Gainesville, 29.572°N, 082.426°W, 19 Jun 2009, *Corogin1000* (FLAS). **Dixie Co.:** Lower Suwannee National Wildlife Refuge, Yellow Jacket Loop Rd., 7 May 2004, *Barichivich s.n.* (FLAS). **Lake Co.:** Roadside on Hwy 19 about 200 yds S of jct with old 441, Tavares, 20 Sep 1971, *Wofford 71-558-A* (TENN). **Putnam Co.:** 75 yds WNW of intersection of trails #10 and #12, 2000 ft E of Camp Area water tower, Univ. of Florida Conservation Reserve, Welaka, T12S, R26E, 27 Mar 1959, *Ward 1206* (FLAS). **Suwannee Co.:** T5S, R14E, S19, ca. 5 mi NW of Ichetucknee Springs, ca. 1.5 mi NNE of Beachville, Oct 1981, *Simons s.n.* (FLAS).

ACKNOWLEDGMENTS

We wish to thank the following herbaria for loans of specimens: A, AUA, FNPS, FSU, FTG, GA, GH, LSU, MISS, OKL, TENN, US, USCH, USF, and UNA. We thank the following people without whose help this study could not have succeeded: Kent Perkins of the University of Florida Herbarium (FLAS) for his generous assistance with processing specimen loans; Brett Jestrow of Fairchild Tropical Garden (FTG) and Jennifer Stafford of the National Park Service herbarium (FNPS) for facilitating our examination of south Florida herbarium specimens; Jimi Sadle, Everglades National Park botanist, for assisting with field work; Karen Kelley, electron microscopy manager, and Kim Backer-Kelley, lab technician, of the ICBR Electron Microscopy Core lab at the University of Florida, for their kindness and expertise; and we thank Dr. Ulf Swenson and an anonymous reviewer for their helpful feedback on this manuscript.

REFERENCES

Allison, J.R. 2006. Big-fruited buckthorn, *Sideroxylon macrocarpum* (Sapotaceae), a long-forgotten Georgia endemic. Sida 22:243–264.

Anderberg, A.A. & U. Swenson. 2003. Evolutionary lineages in Sapotaceae (Ericales): A cladistic analysis based on *ndhF* sequence data. Int. J. Pl. Sci. 164:763-773.

Anderson, L.C. 1996. New geographical and morphological data for *Sideroxylon thornei* (Sapotaceae). Sida 17:343–348.

Avery, G.N. & L.L. Loope. 1980. Endemic taxa in the flora of south Florida. Report T-558. U.S. National Park Service, South Florida Research Center, Homestead, Florida, U.S.A.

Bradley, K.A. & G.D. Gann. 1999. The pine rockland forests of southern Florida. Palmetto 19:12–19.

Chaplin, S.J., R.A. Gerrard, H.M. Watson, L.L. Master, & S.R. Flack. 2000. The geography of imperilment. In: B.A. Stein, L.S. Kutner, and J.S. Adams, eds. Precious heritage: The status of biodiversity in the United States. Oxford University Press, New York, U.S.A. Pp. 159–199.

Clark, R.B. 1942. A Revision of the Genus *Bumelia* in the United States. Ann. Missouri Bot. Gard. 29:155–182.

Cronquist, A. 1945. Studies in the Sapotaceae, III. *Dipholis* and *Bumelia*. J. Arnold Arbor. 26:435–471.

Cronquist, A. 1946. Studies in the Sapotaceae, II. Survey of the North American genera. Lloydia 9:241–292.

Cronquist, A. 1949. Noteworthy plants of Georgia. Castanea 14:101–108.

FNAI (Florida Natural Areas Inventory). 2010. Guide to the natural communities of Florida: 2010 edition. Florida Natural Areas Inventory (FNAI), Tallahassee, Florida, U.S.A.

Gann, G.D., K.A. Bradley, & S.W. Woodmansee. 2002. Rare plants of south Florida: Their history, conservation, and restoration. The Institute for Regional Conservation, Miami, Florida, U.S.A.

Gann, G.D., K.A. Bradley, & S.W. Woodmansee. 2014. The floristic inventory of south Florida database online. http://regionalconservation.org/ircs/database/database.asp. Accessed Dec 2013.

Gautier, L., Y. Naciri, A.A. Anderberg, J.E. Smedmark, R. Randrianaivo, & U. Swenson. 2013. A new species, genus, and tribe of Sapotaceae, endemic to Madagascar. Taxon 62:972–983.

Godfrey, R.K. 1988. Trees, shrubs, and woody vines of northern Florida and adjacent Georgia and Alabama. The University of Georgia Press, Athens, Georgia, U.S.A. Pp. 637–639.

Govaerts, R., D.G. Frodin, & T.D. Pennington. 2001. World checklist and bibliography of Sapotaceae. Royal Botanic Gardens, Kew, Richmond, Surrey, U.K.

Gray, A. 1886. Synoptical flora of North America, second ed. Ivison, Blakeman, Taylor, and Company, New York, U.S.A.

Herring, B.J. & W.S. Judd. 1995. A floristic study of Ichetucknee Springs State Park, Suwannee and Columbia Counties, Florida. Castanea 60:358.

Hodges, S.R. & K.A. Bradley. 2006. Distribution and population size of five candidate plant taxa in the Florida Keys: *Argythamnia blodgettii, Chamaecrista lineata* var. *keyensis, Indigofera mucronata* var. *keyensis, Linum arenicola,* and *Sideroxylon reclinatum* subsp. *austrofloridense*. Final report contract number 401815G011, submitted to U.S. Fish and Wildlife Service. The Institute for Regional Conservation, Delray Beach, Florida, U.S.A.

Judd, W.S. 1987. Floristic study of Morne La Visite and Pic Macaya National Parks, Haiti. Bull. Florida State Mus. Biol. Sci. 32:1–136.

Kartesz, J.T. & K.N. Gandhi. 1990. Nomenclatural notes for the North American Flora. II. Phytologia 68:421–427.

Loope, L.L. & G.N. Avery. 1979. A preliminary report on rare plant species in the flora of National Park Service areas of South Florida. Report M-548. U.S. National Park Service, South Florida Reaearch Center, Homestead, Florida, U.S.A.

Myers, R.L. & D.A. Rodriguez-Trejo. 2009. Fire in tropical pine ecosystems. In: M.A. Cochrane, ed. Tropical fire ecology: Climate change, land use, and ecosystem dynamics. Springer, New York, U.S.A. Pp. 557–605.

O'Brien, J.J., J.K. Hiers, M.A. Callaham, R.J. Mitchell, & S.B. Jack. 2008. Interactions among overstory structure, seedling life-history traits, and fire in frequently-burned Neotropical pine forests. Ambio 37:542–547.

Olmsted, I., W.B. Robertson, J. Johnson, & O.L. Bass. 1983. The vegetation of Long Pine Key, Everglades National Park. Report SFRC-83/05. U.S. National Park Service, South Florida Research Center, Homestead, Florida, U.S.A.

Pennington, T.D. 1990. Sapotaceae. Fl. Neotrop. Monogr. 52:1–770.

Pennington, T.D. 1991. The genera of Sapotaceae. Royal Botanic Gardens, Kew, Richmond, Surrey, U.K., and New York Botanical Garden, Bronx, New York, U.S.A.

Ross, M.S., J.J. O'Brien, & L. Da Silviera Lobo. 1994. Sea-level rise and the reduction in pine forests in the Florida keys. Ecol. Appl. 4:144–156.

Ross, M.S., J.J. O'Brien, R.G. Ford, K. Zhang, & A. Morkill. 2009. Disturbance and the rising tide: The challenge of biodiversity management on low-island ecosystems. Front. Ecol. Environ. 9:471–478.

Sadle, J. Botanist for Everglades and Dry Tortugas National Parks, 40001 State Road 9336, Homestead, FL, 33034.

Saha, A.K., S. Saha, J. Sadle, J. Jiang, M.S. Ross, R.M. Price, L.S.L.O. Sternberg, & K.S. Wendelberger. 2011. Sea level rise and south Florida coastal forests. Clim. Change 107:81–108.

Sanders, R.W. 1987. Identity of *Lantana depressa* and *L. ovalifolia* (Verbenaceae) of Florida and the Bahamas. Syst. Bot. 12:44–60.

Small, J.K. 1900. The genus *Bumelia* in North America. Bull. New York Bot. Gard. 1:437–447.

Smedmark, J.E.E., U. Swenson, & A.A. Anderberg. 2006. Accounting for variation of substitution rates through time in Bayesian phylogeny reconstruction of Sapotoideae (Sapotaceae). Molec. Phylogen. Evol. 39:706-721.

Smedmark, J.E.E. & A.A. Anderberg. 2007. Boreotropical migration explains hybridization between geographically distant lineages in the pantropical clade Sideroxyleae (Sapotaceae). Amer. J. Bot. 94:1491–1505.

Snyder, J.R., A. Herndon, & W.B. Robertson. 1990. South Florida rockland. In: R.L. Myers & J.J. Ewel, eds. Ecosystems of Florida. University of Central Florida Press, Orlando, Florida, U.S.A. Pp. 230–277.

Stride, G., S. Nylinder, & U. Swenson. 2014. Revisiting the biogeography of *Sideroxylon* (Sapotaceae), and an evaluation of the taxonomic status of *Argania* and *Spiniluma*. Austral. Syst. Bot. 27: In press.

Swenson, U. & A.A. Anderberg. 2005. Phylogeny, character evolution, and classification of Sapotaceae (Ericales). Cladistics 21:101–130.

USFWS (U.S. Fish & Wildlife Service, environmental conservation online system). 2013a. Species profile: Everglades bully (*Sideroxylon reclinatum* ssp. *austrofloridense*). http://ecos.fws.gov/speciesProfile/profile/speciesProfile.action?spcode=Q3IM#petitions. Accessed Nov 2013.

USFWS (U.S. Fish & Wildlife Service, environmental conservation online system). 2013b. Species assessment and listing pri-

ority assignment form: *Sideroxylon reclinatum* ssp. *austrofloridense*. http://ecos.fws.gov/docs/candidate/assessments/2014/r4/Q3IM_P01.pdf. Accessed Nov 2013.

URS Corporation, The Institute for Regional Conservation, & Muller and Associates. 2007. Miami Dade County Environmentally Endangered Lands Program management plan, part II: management of specific habitat types, chapter 1: the pine rockland habitat. Submitted to Environmentally Endangered Lands Program by URS Corporation, Miami, Florida, U.S.A.

Ward, D.B., ed. 1979. Volume 5, Plants. In: P.C.H. Pritchard, ed. Rare and endangered biota of Florida. University Presses of Florida, Gainesville, Florida, U.S.A.

Whetstone, R.D. 1985. *Bumelia reclinata* var. *austrofloridensis* (Sapotaceae), a new variety from South Florida, USA. Ann. Missouri Bot. Gard. 72:544–547.

Wunderlin, R.P. & B.F. Hansen. 2008. Atlas of Florida vascular plants. http://www.plantatlas.usf.edu. Accessed Nov 2013.

BOOK REVIEW

JUDY BARRETT. 2013. **Yes, You Can Grow Roses.** (ISBN-13: 978-1-62349-027-0, flexbound). Texas A&M University Press, 4354 TAMU, College Station, Texas 77843-4354, U.S.A. (**Orders:** www.tamupress.com, 1-800-826-8911). $22.95, 104 pp., 79 color photos, index, 6.25" × 8.75".

I have to admit that when I saw the title of this book, I absolutely had to read it. When I was the tag-along fourth child, we moved a few blocks over to a marvelous, large brick house with peonies along the driveway and three huge red rose bushes lining our back porch. They were truly magnificent, blooming profusely and regularly for years and years and years! And as we all—eventually—went to school, Mom would kindly cut roses for each of us to take to our teachers. They were always pleased, thanking us profusely and instructing us to be sure to tell our mother "thank you!" for her.

I had no idea that many people had trouble growing roses, but Judy Barrett's title is absolutely on target. This is a relatively small book, but it is absolutely flawless in telling us how to grow roses in our areas. Moreover, the book is not only beautifully illustrated, but the author carefully explains the proper "care and love of roses—both old and new."

Though the book is slim, it packs a tremendous amount of information, history, and illustrations. Anyone who really likes roses will find genuine delight in the author's presentation. It is truly well written, beautifully explained, and it provides an incredible amount of knowledge, much of which is not well known to many people.—*Helen Jeude, Botanical Research Institute of Texas Volunteer, Fort Worth, Texas, U.S.A.*

JUDY BARRETT is the author of *What Can I Do with My Herbs? How to Grow, Use, and Enjoy These Versatile Plants; What Makes Heirloom Plants So Great? Old-fashioned Treasures to Grow, Eat, and Admire; and Recipes from and for the Garden: How to Use and Enjoy Your Bountiful Harvest.* Her online gardening resource www.HomegrownTexas.com is a favorite site for organic gardeners, and Barrett is a frequent speaker at gardening events and conferences across the South and Southwest.

A MORPHOLOGICALLY BASED TAXONOMIC REEVALUATION OF THE GENUS *STIPULICIDA* (CARYOPHYLLACEAE), WITH COMMENTS ON RANK

Derick B. Poindexter[1], Kateland E. Bennett, and Alan S. Weakley

UNC Herbarium (NCU)
North Carolina Botanical Garden
University of North Carolina
Chapel Hill, North Carolina 27599, U.S.A.
and
[1]Botanical Research Institute of Texas
1700 University Drive
Fort Worth, Texas 76107, U.S.A.
poindexter@unc.edu

ABSTRACT

Stipulicida is a narrowly endemic, monotypic genus as currently circumscribed. Previous studies have attempted to diagnose additional taxa within the genus, but only one species comprised of two varieties is currently accepted. These two varieties, *Stipulicida setacea* var. *setacea* and *S. setacea* var. *lacerata*, demonstrate significant phenotypic divergence and idiosyncratic biogeographical patterns. We utilized multivariate analyses and nonparametric analyses of variance to ascertain morphological distinctions between these two taxa and assess biologically appropriate taxonomic rank. Based on our morphometric data and biogeography, we elevate **S. setacea** var. **lacerata** to species and provide a revised key to the species in the genus.

RESUMEN

Stipulicida es un pequeño género endémico, monotípico tal como se circunscribe normalmente. Estudios previos habían intentado diagnosticar taxa adicionales en este género, pero solo se acepta normalmente una especie con dos variedades. Estas dos variedades, *Stipulicida setacea* var. *setacea* y *S. setacea* var. *lacerata*, muestran una divergencia fenotípica y patrones biogeográficos significativos. Utilizamos un análisis multivariante y un análisis no-paramétrico de varianza para establecer diferencias morfológicas entre estos dos taxa y valorar el rango taxonómico apropiado biológicamente. Basados en nuestros datos morfométricos y biogeografía, elevamos **S. setacea** var. **lacerata** a especie y proporcionamos una clave revisada de especies del género.

INTRODUCTION

The monotypic genus *Stipulicida* Michx. (Caryophyllaceae; Paronychioideae; Polycarpeae) is endemic to the southeastern United States and Cuba (Swanson & Rabeler 2005; Weakley 2012; Kartesz 2013). It consists of minimalist plants with slender stems, ephemeral basal rosettes, short awl-shaped opposite leaves with incised stipules, and diffuse, divaricately-branched inflorescences. The flowers are the most conspicuous morphological feature, consisting of 5 dimorphic sepals (often referred to as "inner" and "outer"), 5 white petals, with the terminal clusters subtended by bracts similar to the leaves. The genus was first described by Andre Michaux (1803) from collections made "*in sabulosis aridis Carolinae*" (= sandy, dry soils of the Carolinas) (Fig. 1). *Stipulicida* as a genus has remained unscathed by current phylogenetic and systematic studies of the Caryophyllaceae, perhaps only because of its omission from them. In the most recent molecular phylogenetic studies of the Caryophyllaceae (e.g., Fior et al. 2006; Harbaugh et al. 2010; Greenberg & Donoghue 2011), *Stipulicida* has been one of the few genera omitted. Consequently, exact subfamilial and tribal placement has not been confirmed and current circumscription is based solely on morphology. At the time of its description, the genus was represented by a single species, *Stipulicida setacea* Michx.

Nash (1895) added another putative species from central peninsular Florida, *Stipulicida filiformis* Nash, which allegedly differed from *S. setacea* based on a much more slender habit, fewer, sessile flowers, and shorter bracts. Small (1903, 1913, 1933) maintained this taxon as distinct within his influential manuals and added

Fig. 1. One of two presumed isotypes of *Stipulicida setacea* (*Michaux s.n.*, P, image #P00156962).

petal shape (constricted at the middle vs. spathulate) as an additional discriminating feature. Judd (1983) sought to address the taxonomic status of *S. filiformis* by conducting extensive fieldwork and observing variation in situ, in addition to morphometric analyses from herbarium specimens. He focused on two quantitative features, stem diameter and number of flowers/inflorescence. Judd (1983) concluded that the plants intergrade broadly with respect to these characters, while also stating that bract size and petal shape failed to provide separation into two taxa, and consequently recognized *S. filiformis* as a mere morphological extreme or ecotype of *S. setacea*, though commenting that its apparent limitation to the Central Florida Ridge was noteworthy due to the number of taxa that are distributed similarly as endemics of xerophytic sands of this region. Ward (2001) felt this pattern (in combination with intergrading morphological distinctions) was sufficient to warrant maintaining it at varietal rank, *Stipulicida setacea* var. *filiformis* (Nash) D.B. Ward, in order to preserve some taxonomic distinction.

James (1957) described the only additional member of this genus to date by recognizing a new variety, *Stipulicida setacea* var. *lacerata* C.W. James, restricted to Florida and the Isle of Pines (now the Isla de la Juventud), Cuba. This variety was considered distinguishable from the typical variant by the presence of lacerate sepals and outer sepals that were mucronate, as well as "essentially allopatric" distributions. James' (1957) rationale for infraspecific rank was explicit:

> "The collection of F.W. Hunnewell (no. 8955, Highlands Co., Fla.), from the eastern limits of the range of var. *lacerata* was the only one seen which consisted of plants of both varieties. The specimen of var. *lacerata* in this collection is somewhat atypical. This, in addition to the fact that there is not a clear-cut discontinuity in the shape of the sepals, indicates that there may be some gene flow between these taxa."

During the course of his study, Judd (1983) also noticed the distinctive nature of lacerate-sepaled plants and felt they were adequately assigned to varietal status due to presence of intermediate plants from Highlands and Volusia Counties.

At present, the general consensus (as shown by recent floras covering all or parts of the distribution of the genus: Wunderlin & Hansen 2011; Swanson & Rabeler 2005; Weakley 2012) has been to follow the taxonomic schema established by Judd (1983) by recognizing a single species within the genus, with two relatively well-marked varieties, *Stipulicida setacea* var. *setacea* (incl. *S. filiformis*) and *S. setacea* var. *lacerata*. The distribution of the genus as a whole is narrow, restricted to the Atlantic and Gulf Coastal Plain (Fig. 2). Of these two varieties, var. *setacea* is the most widespread, extending from southeastern Virginia to Florida and west to eastern Louisiana. The second variety, var. *lacerata*, is much more narrowly distributed in only peninsular Florida, and disjunct in Cuba (Isla de la Juventud) (Wunderlin & Hansen 2005; Weakley 2012).

Previous classification attempts have lacked a comprehensive, systematic approach in documenting key morphological differences between these two entities and have failed to account for what we believe are significant characters, in addition to the seemingly conspicuous sepal morphology. Consequently, we chose to re-evaluate the distinctiveness of the two currently recognized varieties using a broader morphometric analysis.

METHODS

We examined selected specimens from across the entire distribution of the species (Fig. 2). Physical material was examined from GH, NCU, and USF. The southernmost locality (Isla de la Juventud, Cuba) was examined digitally (*Britton 14200,* NY, image #NY01511627). We also studied the original type description and illustration of *Stipulicida setacea* from Michaux (1803), as well as the putative isotypes from the Michaux Herbarium at the Muséum National d'Histoire Naturelle (*Michaux s.n.,* P, image #P00156961 and #P00156962). In addition, we examined digital images of types of the other named taxa, including *S. filiformis* (*Nash 14*, GH, image #GH00038011, MICH, image #MICH1111011, MIN, image #MIN1002897, NY, image #NY00353092, P, image #P04925565 and #P04925568, US, image #US00103374 and #US00931431) and *Stipulicida setacea* var. *lacerata* (*Tracy 6828*, GH, image #GH00038012, MSC, image #MSC0092943, NY, image #NY00353093, US, image #US00103375). We selected 41 representative specimens of *Stipulicida setacea* (without discrimination between var. *setacea* and var. *filiformis*) and 26 specimens of var. *lacerata* for morphometric analysis to assess

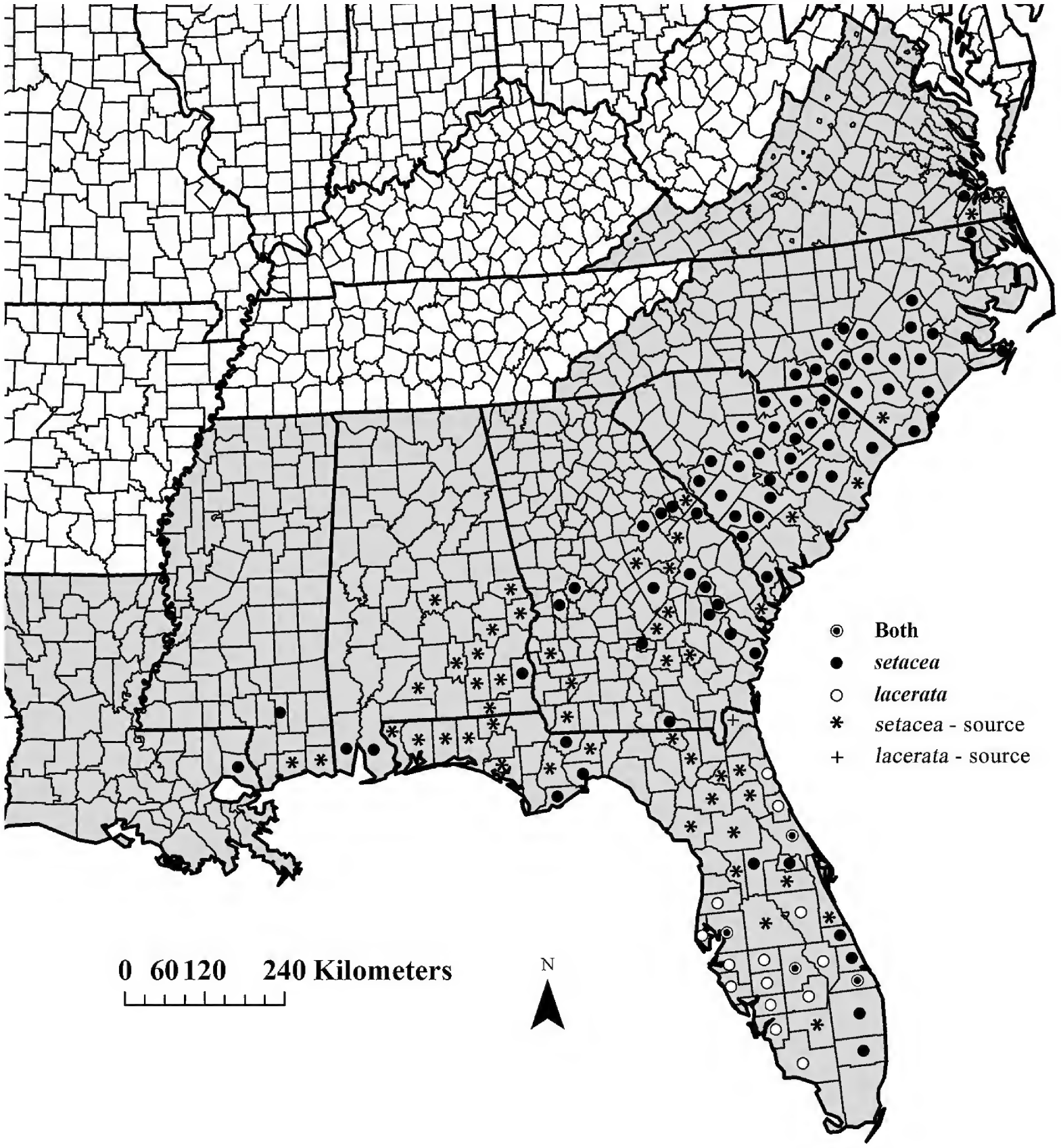


Fig. 2. Distribution of *Stipulicida setacea* specimens examined for this study. Records that have not been physically examined but are from reliable sources (Wunderlin & Hansen 2008; Kartesz 2013) are included. State-level occurrence is indicated by shading.

previously described features (see Nash 1895; James 1957; Judd 1983) and to seek additional diagnostic features. Specimens measured are denoted within the Appendix (below).

We examined nine continuous characters (Table 1). All characters were selected at random, with the exception of the length of the longest mucro (LOM), which necessitated a comprehensive scan of each specimen. In addition, we made general observations regarding the degree of laceration and fimbriate nature of specimens, as well as overall gestalt. All measurements were made with a TDI International, Inc. Micro Ruler.

To determine specimen groups and elucidate the most diagnostic variables, we used principal components analysis (PCA). To avoid weighting characters, we examined pairwise correlation coefficients (CC) that

Table 1. Morphological characters measured from herbarium specimens with abbreviations in parentheses. Those characters used in multivariate analyses are denoted by an asterisk.

1	Length of outer sepal (LOS)
2	Length of inner sepal (LIS)*
3	Width of outer sepal (WOS)*
4	Width of inner sepal (WIS)
5	Stem width below terminal flower cluster (SWF)*
6	Stem width below lowest branching node (SWN)*
7	Length of longest mucro of the outer sepal (LOM)*
8	Difference between inner and outer sepal length (DSL)
9	Difference between inner and outer sepal width (DSW)

may indicate genetically linked characters and excluded those that exceed a standard threshold of > 0.7. The only exception to this concerned the characters LOM and WOS, which exhibited a strong correlation, but we believe that this correlation may be artificial, as it is very unlikely that these two traits would be due to allometric scaling. Thus, we have decided to retain them both within our analyses. For PCA, we conducted analyses on a correlation matrix, which consisted of data that is standardized so that each variable had a mean of 0 and standard deviation of 1. We used only the following five continuous characters in this analysis: LIS, LOM, SWF, SWN, and WOS.

We performed a Bartlett test for homogeneity of group variances on each variable. Variables that demonstrated variances that were significantly heterogeneous were log-transformed before further analysis. We tested each variable for deviations from normality using the Goodness-of-Fit test. Nearly all variables deviated significantly from a normal distribution. We chose to maintain a conservative approach using the nonparametric Kruskal-Wallis test and employed the Steel-Dwass method (i.e., a nonparametric version of the Tukey Honestly Significantly Different test) to further detect the amount of differences between groups. Principal components and nonparametric analyses were conducted using JMP® version 11 software (SAS Institute, Cary, NC) on an Apple ® MacBook Pro™ computer.

RESULTS

Principal components analysis yielded strong resolution with *Stipulicida setacea* var. *lacerata* and var. *setacea* clearly separating within the ordination space (Fig. 3). Principal component 1 was responsible for 57.3% of the observed variation and principal component 2 was responsible for 16.7%, for a total of 74.0% of the variance explained. An examination of specimens likely to be assigned to *Stipulicida setacea* var. *filiformis* based on their "wiry" habit and geographic distribution revealed that they were embedded within the var. *setacea* data cluster (data not shown). Likewise, the Kruskal-Wallis test supported two distinct groups. Both taxa differed from each other with respect to means of nearly all measured characters except LOS and LSW (Table 2).

DISCUSSION

The genus *Stipulicida* has recently been treated as monospecific and is currently represented by one species, *Stipulicida setacea*, and two varieties (Swanson & Rabeler 2005; Weakley 2012): *S. setacea* var. *setacea* and *S. setacea* var. *lacerata*. The paucity of distinctive morphological characters found within the genus have perhaps led to a general acceptance of this current taxonomic treatment and a lack of interest in further study. This research sought to reevaluate the distinctiveness of these two entities through a more rigorous morphometric approach that implemented multivariate analyses, in an attempt to address appropriate taxonomic ranks. We selected several characters that had previously been emphasized by other authors, but also generated new characters (e.g., outer and inner sepal length differences) that have aided in the further discrimination these taxa. Despite considerable overlap, many diagnostic trends are apparent. Though both taxa have dimorphic sepals, those of var. *lacerata* are distinctly lacerate/fimbriate and usually unequal in length (**Fig.** 4A–B). Conversely, the sepals of var. *setacea* are mostly entire margined and often even in length (Fig. 4C–D). *Stipulicida setacea* var. *lacerata* exhibits longer and wider inner sepals on average, and outer sepals that are generally wider and with a more pronounced mucronate apex (which is usually obsolete in var. *setacea*). Variety *lacerata* also appears generally stouter than var. *setacea* in all aspects as evidenced by significantly greater average stem widths (Table 2).

A combination or suite of characters rather clearly defines these two taxa within ordination space (Fig. 3).

Table 2. Means ± 1 SD and ranges for morphological characters measured. Character abbreviations correspond to those in Table 1. All measurements are in millimeters. N equals the sample size. Within a row, means with different superscripts differ significantly (Kruskal-Wallis, $P < 0.05$).

Character	S. setacea (N=41)	S. lacerata (N=26)
1. LOS	1.4 ± 0.2[a] (0.9 - 1.8)	1.5 ± 0.29[a] (1.0 - 2.0)
2. LIS	1.5 ± 0.21[a] (1.0 - 1.9)	1.8 ± 0.32[b] (1.1 - 2.2)
3. WOS	0.4 ± 0.1[a] (0.2 - 0.7)	0.8 ± 0.1[b] (0.6 - 1.1)
4. WIS	0.6 ± 0.1[a] (0.4 - 0.9)	1.0 ± 0.2[b] (0.7 - 1.4)
5. SWF	0.3 ± 0.1[a] (0.2 - 0.6)	0.4 ± 0.1[b] (0.3 - 0.5)
6. SWN	0.5 ± 0.1[a] (0.3 - 0.9)	0.8 ± 0.1[b] (0.5 - 1.1)
7. LOM	0.0 ± 0.04[a] (0.0- 0.1)	0.3 ± 0.1[b] (0.2 - 0.5)
8. DSL	0.1 ± 0.1[a] (-0.2 - 0.5)	0.3 ± 0.2[b] (0.1 - 0.7)
9. DSW	0.2 ± 0.1[a] (0.1 - 0.5)	0.2 ± 0.1[a] (0.0 - 0.4)

As a secondary measure, we selected specimens that were either originally determined as *Stipulicida setacea* var. *filiformis* (or *S. filiformis*) or were within the originally described distribution and ecological preference of this taxon. We mapped these specimens within our PCA and found them to be centrally nested within *S. setacea* var. *setacea* (data not shown), which further supports Judd's (1983) conclusion that *S. filiformis* is not distinct from var. *setacea*. These data, in conjunction with known biogeographic patterns, suggests that *Stipulicida setacea* var. *lacerata* and *S. setacea* var. *setacea* are sufficiently distinct to be recognized as discrete entities. However, previous authors (James 1957; Judd 1983) have indicated that a handful of specimens in areas of sympatry are intermediate. The one specimen (Highlands County, FL, *Hunnewell 8955*, GH) cited by James (1957) as a mixed collection was included in our analyses, focusing on the portion he described as "atypical" *Stipulicida lacerata* and it was nested within the var. *setacea* data cluster. Though we did not examine two of the additional specimens mentioned as intermediate by Judd (1983), we did examine one from Volusia County, FL (*D.S. & H.B. Correll 51934,* USF). This specimen appeared to be a mixed collection with one branch that was unassociated with a parent plant, but mounted on top of another such that it was not easily detectable as separate. We measured both this stem, which based on our PCA was nested within var. *lacerata*, and another full plant on the sheet separately, which was nested within var. *setacea*. Since we have not examined other putative intermediates reported, we cannot attest to their identity.

We also recognize that some within taxon variation is apparent and could lead to perceived intermediacy. For instance, some trends were observed that may not be readily apparent, e.g., northernmost populations of var. *setacea* exhibit acute to slight retuse outer sepal apices, with progressively more retuse to strongly obcordate apices as one progresses further south. This pattern is also seen with northern populations possessing inner and outer calyces that are narrow and subequal in length, while those of southern populations are wider and often unequal, as well as shorter in comparison. Even the amount of lacerations/fimbriae of var. *lacerata* can vary somewhat and an examination of an entire specimen is necessary to evaluate the plasticity in this qualitative character state. James (1957) also remarked that the specimens from Cuba do not have as strongly lacerate sepals as those from Florida, though we found this to be within the range of variation of this taxon.

How does this analysis translate to taxonomic decision-making? We find that (despite variation within each) two morphologically distinctive entities ("*lacerata*" and "*setacea* s.s.") are consistently separable and identifiable using a suite of morphological characters. The several morphological characters are correlated with one another, and do not randomly assort. An ordination confirms the more subjective assessment that two morphologically distinct entities can be recognized. No true intermediates have been seen; and a few "putative intermediates" cited by previous workers prove not to be, based on careful analysis. Neither are there situations in which the correlation of the seemingly independent characters breaks down. When mapped, these two morphologically distinct entities have distinctive and different distributions, with a substantial area of overlap in peninsular and northeastern Florida. In areas of distributional overlap, intermediates are not seen, although at least one studied collection is mixed. Each of the distribution patterns shown by the two enti-

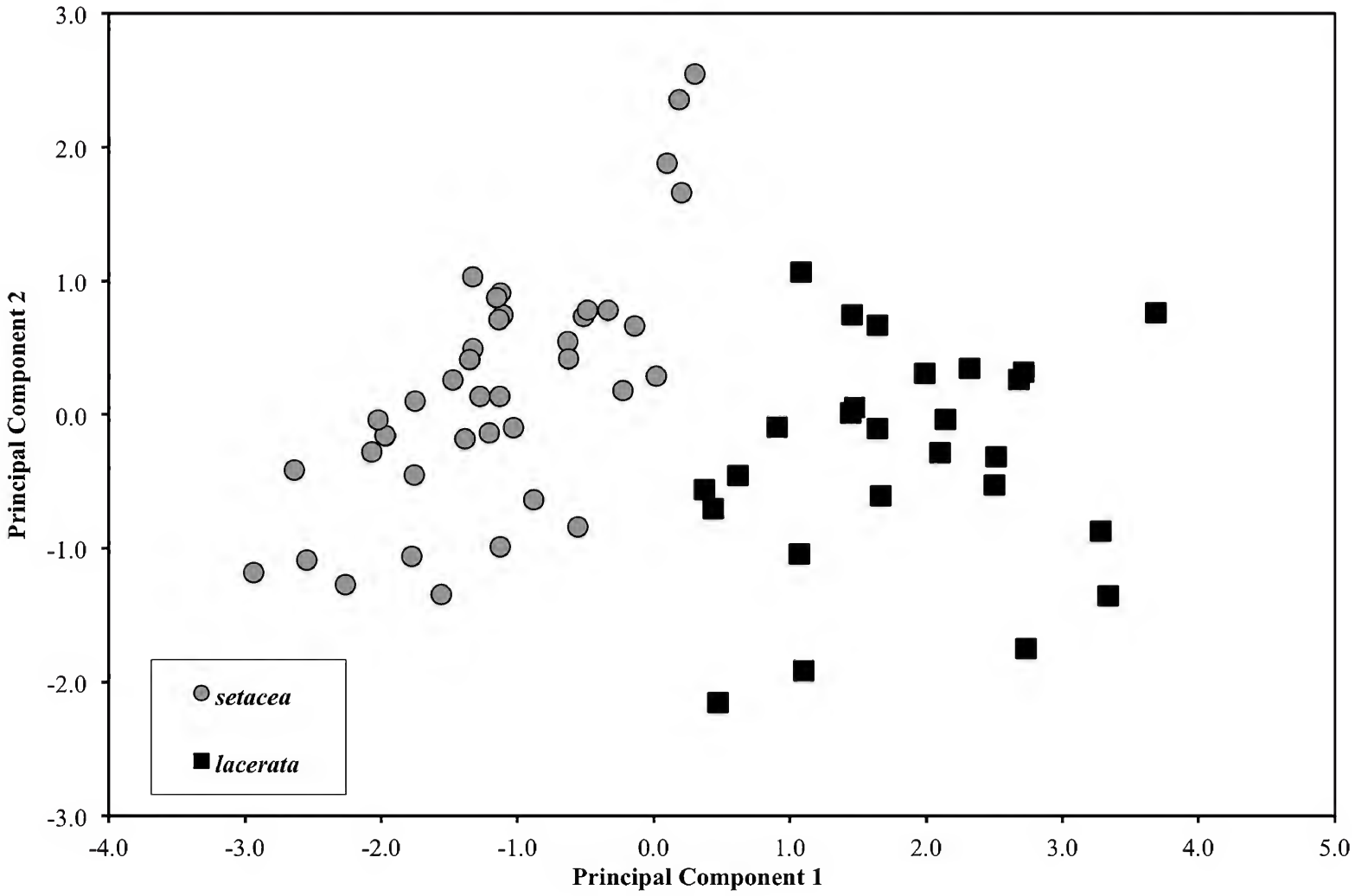


Fig. 3. Principal components analysis (PCA) of seven morphological characters (LOC, SWN, SWF, OSL, ISL, OSW, ISW) measured from *Stipulicida lacerata* and *S. setacea*.

ties is a distribution pattern represented by a large number of other angiosperm (and even animal) species: the "se. Virginia to s. Florida, west to e. Louisiana" distribution of "*setacea* s.s." and the "Florida peninsula" distribution (with optional disjunction into the West Indies) of "*lacerata*"—both commonly repeated distributions across many organism groups and therefore likely to show "biogeographic signal" (see Sorrie & Weakley 2001, 2006).

If two taxonomic entities are warranted, what should their taxonomic rank be? Based on the analysis presented above, we believe that these two entities represent independent evolutionary entities (by biological, evolutionary, and/or phylogenetic criteria) at this time—species per most modern species concepts. A frequently used, though usually not explicitly stated, assumption suggests that the magnitude of morphological difference is well-correlated with taxonomic rank—a paradigm that might be characterized as "if you can tell two entities apart with readily observable, macroscopic characters, they are species, but if the characters require magnification or are 'fussy', they are infrataxa (subspecies or varieties)". Ward (2012), in a paper proposing the reduction of dozens of Southeastern United States species of vascular plants species to varietal status, makes some of these points more explicitly, decrying the proliferation of "microspecies". The following statement regarding *Conradina etonia* may be regarded as an example: "Details of indumentum, of leaf venation, of size and pilosity, and of stamen pubescence, while wholly persuasive of the taxon's genetic separateness, do not rise to the level of difference to be found among related species" (Ward 2012). But modern biological and phylogenetic species concepts are not based on the magnitude of morphological variation but on the degree to which two entities are demonstrably separate biological/evolutionary entities—not determinable by the size of their characters but by inductive reasoning (as in the previous paragraph). The consistency and evolutionary meaningfulness of the characters is what tells the tale, not their size; small plants with small characters are not less significant evolutionary entities.

Gill (2014) has also recently, and significantly, raised the issue of "burden of proof" in modern taxonomic decision-making. When previous taxonomic studies have proposed a range of conclusions (splitting to lumping), what is the null hypothesis and on whom does the burden of proof lie; to disprove previous lumping, or to disprove previous splitting? Gill (2014) argues that in bird studies, allopatric "populations" have almost always been shown, after detailed genetic study to warrant taxonomic recognition at species rank, and that the burden of proof should now be (based on this preponderant pattern) on those who favor "lumping". Additionally, this assumption is more conservationally helpful and parsimonious, in providing a more accurate hypothesis of significant evolutionary entities requiring conservation attention. In much less well-studied groups (such as vascular plants of the southeastern United States), patterns of previous studies are less clear, but generally also show that recent rigorous and/or molecular-based studies show a greater general reliability of older morphological studies (reflected in the treatments of Small, 1903, 1913, and 1913) than the casual lumping seen in many late 20th century and early 21st century floras (e.g., Radford et al. 1968; Wunderlin & Hansen 2011). As demonstrated by Weakley (2005), eastern North American floras from the 1960s to 1990s instituted a trend of lumping, often without additional studies of the plants themselves either in the field or in herbaria. This has led to a current misimpression that many "splits" (recognized, for instance by J.K. Small in the Southeast and Fernald in the Northeast) have been disproven, when most have received little or no additional study since the first half of the 20th century.

For *Stipulicida*, previous taxonomic studies have concluded that there are one, two, or three entities, and at various ranks. We concede that we have not presented the ultimate and final analysis, based on an ideal and complete (as of methodologies available in 2014) synthesis of molecular data, morphological character analysis, and population biology studies. Such a study would require substantial effort, and with thousands of such taxonomic problems remaining in the southeastern United States flora and few investigators and even less funding, it is not our highest priority. We offer this analysis and set of taxonomic conclusions (resulting in the recognition of two taxa, not one or three) as a current, yet disprovable hypothesis of the taxonomy of *Stipulicida*.

We conclude that the best evidence available supports the recognition of two specifically distinct entities within *Stipulicida*, and therefore here elevate var. *lacerata* to the rank of species and provide a revised identification key to members of the genus.

Stipulicida lacerata (C.W. James) D.B. Poind., K.E. Bennett, & Weakley, comb. et stat. nov. *Stipulicida setacea* var. *lacerata* C.W. James; Rhodora 59:98. 1957. TYPE: UNITED STATES. FLORIDA. Pinellas Co.: Dunedin, 14 Apr 1900, *Tracy 6828* (HOLOTYPE: GH!, image; ISOTYPES: MSC!, image, NY!, image, US!, image).

KEY TO SPECIES OF *STIPULICIDA*

1. Sepal margins lacerate-fimbriate; outer sepals often much shorter than inner sepals (usually by 0.1–0.5 mm); tips of the outer sepals with longest mucro (0.1–)0.2–0.4(–0.5) mm; [of FL and Cuba (Isla de la Juventud)] _____ **S. lacerata**
1. Sepal margins entire or frayed (not lacerate-fimbriate); outer sepals subequal to slightly shorter or longer than inner sepals (usually by 0.0–0.2 mm); tips of the outer sepals acute to obtuse or retuse-obcordate; with longest mucro or apicule 0.0–0.1 mm; [of se. VA south to s. FL, west to e. LA] _____ **S. setacea**

Additional studies of the interesting, and seemingly isolated, genus *Stipulicida* are warranted. Population genetic and molecular studies could elucidate additional patterns of variation, and more definitively clarify the status of the alleged "*filiformis*" entity and the widely disjunct population of *S. lacerata* in the Isla de la Juventud (Cuba), as well as providing additional confirmation of our proposed species-level distinction of *S. setacea* and *S. lacerata*. Additionally, the failure to include *Stipulicida* in recent molecular studies of the family leaves its phylogenetic affinities and exact taxonomic placement within the Caryophyllaceae uncertain and conjectural.

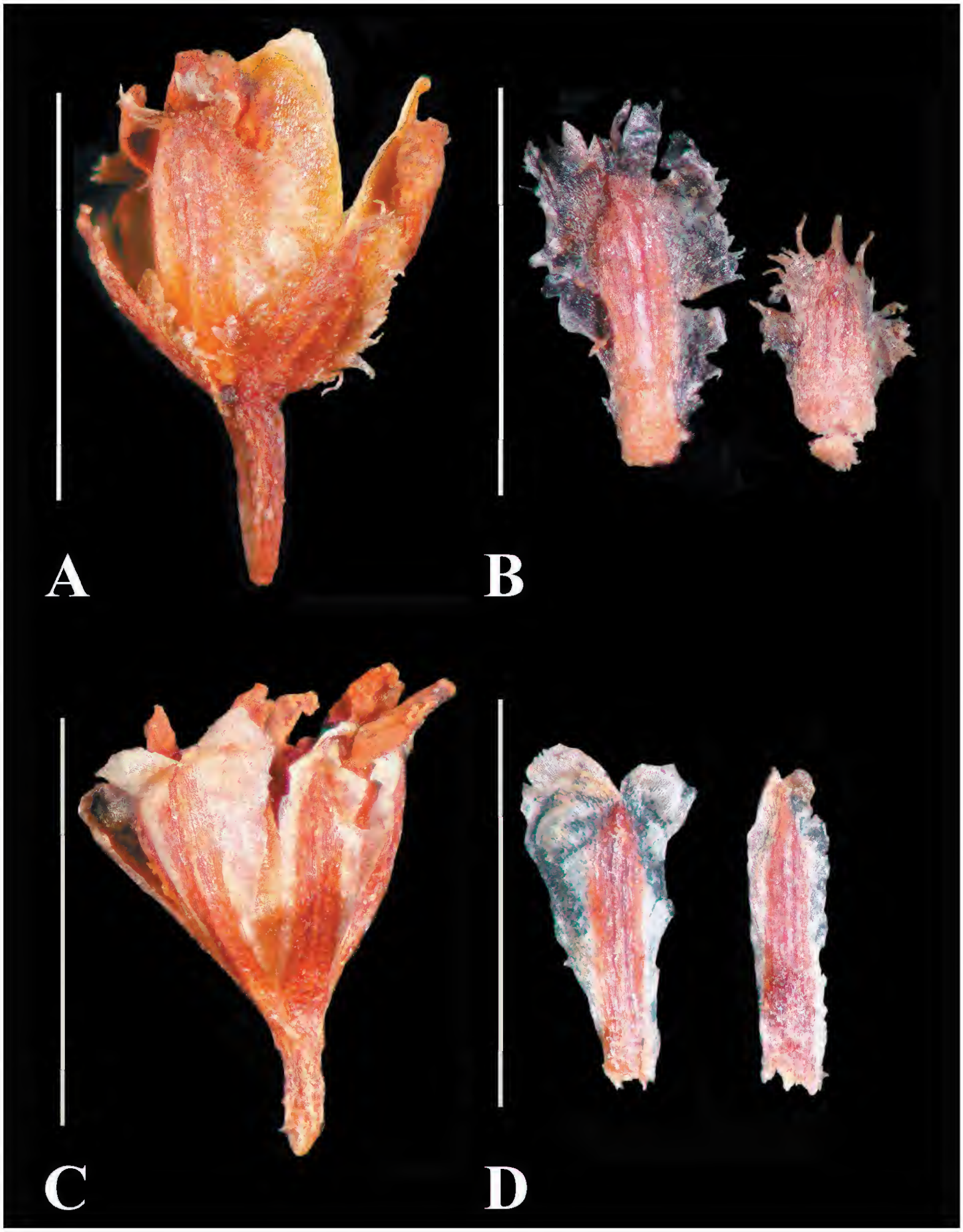


Fig. 4. Mature capsules, calyces and calyx lobes (inner lobes = left, outer lobes = right) of **A–B**) *Stipulicida lacerata* (Sarasota County, Florida, *Perkins s.n.*, NCU) and **C–D**) *S. setacea* (Bamberg County, South Carolina, *Ahles 25982*, NCU). Scale bar = 2 mm.

APPENDIX

List of representative specimens. Those utilized for morphometric analysis are denoted by an asterisk.

***Stipulicida lacerata* (C.W. James) D.B. Poind., K.E. Bennett, & Weakley—U.S.A. FLORIDA. Charlotte Co.:** NE of Pirate Harbor, 10 May 1990, *Orzell 13438* (USF); Prairie/Shell Creek, 11 May 2009, *Franck 1250* (USF*). **Collier Co.:** Immokalee city limits, 7 Apr 1968, *Lakela 31361* (USF*); vicinity of Lake Trafford, 31 Jul 1968, *Lakela 31560* (USF*). **De Soto Co.:** W side of Peace River, 31 Jul 2008, *Franck 771* (USF*). **Flagler Co.:** NE of US 1, 1 May 2006, *Slaughter 14843* (USF*). **Glades Co.:** Fisheating Creek Wildlife Management Area, 30 May 2010, *Franck 2184* (USF*). **Hardee Co.:** AMAX property, 26 Mar 1979, *Arcuri 856* (USF); Goose Pond Rd., 9 Apr 1981, *Robinson 129* (USF*). **Highlands Co.:** S of Old Venus, 1 May 1958, *Cooley 6137* (USF*); Archibold Biological Station, 24 Dec 1960, *Craighead s.n.* (USF). **Hillsborough Co.:** Tarpon Springs, 23 Mar 1923, *Churchill s.n.* (GH*); Little Manatee River, 21 Feb 1974, *Shuey s.n.* (USF); Little Manatee River State Park, 11 Apr 1999, *Myers 342* (USF*). **Lee Co.:** Myers, 1900, *Hitchcock 5* (GH*); Fort Meyers, May 1928, *Small s.n.* (NCU*); Koreshan State Park, US 41, 20 Apr 1964, *Lakela 26983* (USF); Bonita Springs, 13 Feb 1965, *Foster s.n.* (USF); Koreshan State Park, 1 mi S of Estero, 1 Mar 1969, *McCart 10,630* (NCU*). **Manatee Co.:** Wingate Creek State Park, 14 Mar 1991, *Weber WC0046* (USF); Lake Manatee State Recreation Area, 14 Apr 1992, *Weber LM0039* (USF*). **Martin Co.:** Jonathan Dickinson State Park, 9 Feb 1969, *McCart 10,522* (NCU*); Hobe Mountain, Sep 1987, *Woodbury 87* (USF*). **Okeechobee Co.:** Kissimmee Prairie, 27 Apr 1923, *Small 10898* (GH*). **Osceola Co.:** Kempfer Ranch, 9 Mar 1976, *Huck 1728* (NCU*). **Pasco Co.:** SE of Lacoochee, 29 Jun 1992, *Orzell 19761* (USF); Starkey Wilderness Park, 20 Mar 2004, *Ferguson 659* (USF). **Pinellas Co.:** NE of Clearwater, 3 Apr 1970, *Lelong 5344* (NCU*); Highway 19, 3 Apr 1970, *Rogers 2877-B* (NCU*); Dunedin Hammock, 1 May 1977, *Genelle 2728* (USF*); Magnolia Creek, 24 Mar 1988, *Fleming 3981* (USF*). **Sarasota Co.:** Sarasota, 3 Jan 1943, *Perkins s.n.* (NCU*); Oscar Scherer State Park, 27 Aug 1994, *Cole OSO257* (USF); Deep Prairie Creek Preserve, 23 Aug 2007, *Franck 332* (USF). **St. Johns Co.:** Hastings, 11 Jun 1975, *Godfrey 74329* (NCU*). **Volusia Co.:** Route 415, 26 May 1981, *Correll 51934-B* (USF*); Tomoka State Park, 15 Mar 2006, *Kunzer 1454* (USF*).

***Stipulicida setacea* Michx.—U.S.A. ALABAMA. Baldwin Co.:** Point Clear, 20 Mar 1883, *Mohr s.n.* (NCU); Orange Beach, 4 Jul 2012, *Spaulding 13613* (NCU). **Henry Co.:** NE of Abbeville, 8 May 1989, *Orzell 9538* (NCU). **Mobile Co.:** Little Dauphin Island, 15 Jul 1965, *Bray 442* (NCU); S of Audubon Bird Sanctuary, 15 Aug 1966, *Bray D995* (NCU); Dauphin Island, 15 May 1972, *Lelong 6502* (NCU*).—**FLORIDA. Broward Co.:** Deerfield Beach, 17 Jun 1978, *Correll 49877* (NCU*); **Franklin Co.:** near Appalachicola, s.d., *Curtiss exsiccata no. 336* (NCU*); S of US Route 98, 22 May 1971, *Godfrey 70233* (NCU*). **Gadsden Co.:** near Lake Talquin, 29 Apr 1977, *Anderson 4430* (NCU*). **Highlands Co.:** Sebring, 7 Mar 1924, *Hunnewell 8955* (GH*); S of Childs, 25 Apr 1960, *Ray 9788* (NCU*); S of Sebring, 25 Apr 1960, *Ray 9731* (NCU*). **Hillsborough Co.:** W of Plant City, 8 Mar 1963, *Wall 30* (NCU). **Indian River Co.:** near Sebastian, 3 Apr 1921, *Small 9864* (NCU*). **Lake Co.:** Howey-in-the-Hills, 29 April 1960, *Cooley 7352* (NCU*). **Martin Co.:** Hobe Sound, 22 May 1960, *Atwater M-214* (NCU*). **Palm Beach Co.:** W of Lantana, 5 Aug 1952, *Howard 12959* (NCU*); West Palm Beach, 14 Feb 1969, *Cassen 461* (NCU*). **Seminole Co.:** S of Wagner, 3 May 1960, *Cooley 7612* (NCU*). **St. Lucie Co.:** E of US 1, 28 Jul 1962, *Lakela 25219* (NCU). **Volusia Co.:** Route 415, 26 May 1981, *Correll 51934-A* (USF*). **Wakulla Co.:** Mashes Island, 24 Apr 1955, *Godfrey 53207* (NCU*).—**GEORGIA. Ben Hill Co.:** NNE of Fitzgerald, 4 May 1968, *Faircloth 5189* (NCU*). **Candler Co.:** 32°16'N, 81°57'W, 3 May 1965, *Cook 167* (NCU*); E of the Canoochee River, 13 May 1975, *Walker 134* (NCU). **Echols Co.:** Mayday, 15 May 1969, *Faircloth 5831* (NCU*). **Emanuel Co.:** N of the Ohoopee River, 18 May 1976, *Boufford 18438* (NCU*). **Evans Co.:** NW of Claxton, 9 May 1977, *Oliver 96* (NCU). **Hancock Co.:** NE of Sparta, 3 Jun 1972, *Williams s.n.* (NCU*). **Laurens Co.:** E of Dublin, 26 Jul 1967, *Logue 2113* (NCU). **Long Co.:** near Beard's Bluff, 10 Apr 1963, *Bozeman 2543* (NCU). **Marion Co.:** S of Geneva, 17 May 1974, *Faircloth 7770* (NCU). **McDuffie Co.:** S of Thomson, 29 Jul 1950, *Duncan 11558* (NCU); N of Thomson, 18 May 1952, *Duncan 13568* (NCU). **McIntosh Co.:** NW of Cox, 4 Jun 1962, *Bozeman 710* (NCU). **Richmond Co.:** near August Airport, 17 Jun 1950, *Radford 5358* (NCU*); E of Briar Creek, 16 May 1958, *Duke 614* (NCU). **Tattnall Co.:** NW of Reidsville, 11 Jun 1961, *Ahles 54183* (NCU*). **Taylor Co.:** W of Butler, 16 May 1974, *Faircloth 7559* (NCU). **Warren Co.:** NE of Sparta, 3 Jun 1972, *Williams s.n.* (NCU).—**LOUISIANA. St. Tammany Co.:** E of Slidell, 17 May 1983, *Thomas 83658* (NCU*). —**MISSISSIPPI. Forrest Co.:** Hattiesburg, 29 Jun 1971, *Rogers 6585* (NCU*).—**NORTH CAROLINA. Anson Co.:** SE of Lilesville, 30 Jun 1956, *Radford 13452* (NCU). **Bladen Co.:** Sandy places, 10 Jun 1898, *Ashe s.n.* (NCU); W of White Oak, 22 Jun 1957, *Ahles 29167* (NCU); S of Cumberland County line, 12 May 1971, *Leonard 4784* (NCU). **Brunswick Co.:** Boiling Springs Lakes Preserve, 6 Jun 2006, *Morris 052605-04* (NCU). **Carteret Co.:** E of Bogue, 21 Jun 1947, *Wood 7014* (NCU); N of NC 24, 15 May 1976, *Snyder 814* (NCU); Patsy Pond, 22 May 1976, *Wilson 1782* (NCU). **Craven Co.:** W of Vanceboro, 19 Jul 1958, *Radford 37647* (NCU). **Cumberland Co.:** S of Fayetteville on NC 53, 11 May 1941, *Radford 1063* (NCU); N of Cedar Creek, 2 Aug 1954, *Munson s.n.* (NCU); SE of Spring Lake, 4 May 1957, *Ahles 24290* (NCU); WSW of Cumberland, 27 Jun 1957, *Ahles 29729* (NCU). **Duplin Co.:** NE of Magnolia, 27 Apr 1957, *Ahles 24047* (NCU*); N of Scotts Store, 15 Jun 1957, *Ahles 28407* (NCU*). **Gates Co.:** White Oak Pocosin, 30 May 1958, *Duke 805* (NCU*); near Chowan River, 10 Jun 1989, *Musselman s.n.* (NCU*). **Harnett Co.:** SE of Spout Springs, 7 May 1946, *Downs 13446* (NCU*); N of Lillington, 11 May 1946, *Radford 3047* (NCU*). **Hoke Co.:** SW of Bowmore, 12 May 1957, *Ahles 25089* (NCU); Ashley Heights, 26 Jun 1957, *Ahles 29353* (NCU). **Lee Co.:** N of Moore County line, 24 May 1940, *Radford 137* (NCU); SE of St. Andrews Church, 7 Jun 1958, *Stewart 469* (NCU). **Lenoir Co.:** W of Deep Run, 22 Jun 1957, *Radford 25701* (NCU). **Moore Co.:** Weymouth Woods State Park, 13 Jun 1965, *Ahles 59622* (NCU); Weymouth Woods-Sandhills Nature Preserve, 12 May 1973, *Carter 556* (NCU); N of Southern Pines, 11 Jun 1978, *Reed 106667* (NCU). **New Hanover Co.:** Wilmington, May 1867, *Canby s.n.* (NCU*); NW of Carolina Beach, 12 Jun 1958, *Bell 12691* (NCU); UNC-Wilmington, 2 Jun 1975, *Sieren 1330* (NCU). **Pender Co.:** SE of Montague, 26 Jul 1953, *Radford 7400* (NCU); NE of Hampstead, 13 Jun 1957, *Ahles 28003* (NCU). **Richmond Co.:** S of Moore County Line, 4 Jun 1958, *Duke 976* (NCU). **Robeson Co.:** S of Red Springs, 21 Jun 1957, *Ahles 28922* (NCU). **Sampson Co.:** SE of Highsmith, 5 May 1957, *Ahles 24643* (NCU); W of Clement, 28 Jun 1957, *Ahles 30058* (NCU). **Scotland Co.:** W of Laurinburg, 8 May 1957, *Ahles 24817* (NCU); S of Hoke - Scotland County line, 20 Jun 1957, *Ahles 28580* (NCU); NW of US 15-501, 18 May 1973, *Sharp 1592* (NCU); Green Pond, 2 Nov 1984, *Berg 1198* (NCU); Scotland Road Annual Burn Site, 2 Jun 2007, *McCormick s.n.* (NCU). **Wayne Co.:** W of Seven Springs, 21 Jun 1957, *Radford 25480* (NCU). **Wilson Co.:** NW of Sims, 28 Jul 1958, *Radford 38003* (NCU).—**SOUTH CAROLINA. Darlington Co.:** Cannon's, 8 Jul 1909, *Coker s.n.* (NCU); Hartsville, 15 May 1910, *Coker s.n.* (NCU); W of Black Creek, 12 Jul 1920, *Norton s.n.* (NCU); W of Hartsville, 22 Apr 1921, *Norton s.n.* (NCU); Hartsvlle, 10 May 1932, *Smith s.n.* (NCU); near Black Creek along Highway 34, 23 May 1940, *Smith 1664* (NCU); Kalmia Gardens., 27 Sep 1940, *Smith*

1668 (NCU); Witherspoon Island, 3 Jun 1941, *Smith 612* (NCU); E side of Lynches River above Clyde, 18 Jul 1941, *Smith 777* (NCU); Coker College Arboretum, 26 Apr 1944, *Matthews s.n.* (NCU). **Dillon Co.:** NNE of Oak Grove, 18 Apr 1957, *Ahles 23281* (NCU); NW of Dillon, 12 Jun 1957, *Ahles 27802* (NCU); **Edgefield Co.:** S of Trenton, 4 Jul 1957, *Radford 26445* (NCU). **Fairfield Co.:** W of Lugoff, 24 Aug 1961, *Radford 44256* (NCU). **Florence Co.:** NE of Lynches River, 30 Jun 1958, *Bell 13449* (NCU). **Horry Co.:** Myrtle Beach, 23 Jun 1931, *Coker s.n.* (NCU). **Jasper Co.:** Turtle Island, 14 Jun 1997, *McMillan 2492* (NCU). **Kershaw Co.:** N of Bethune, 3 Aug 1958, *Duke 1846* (NCU). **Lancaster Co.:** SW of Heath Springs, 6 Jun 1957, *Ahles 27403* (NCU). **Lee Co.:** NE of Bishopville, 6 Jun 1957, *Radford 24295* (NCU); NE of Lucknow, 26 Jul 1957, *Radford 17340* (NCU). **Lexington Co.:** SE of Lexington, 27 May 1957, *Radford 23315* (NCU). **Marlboro Co.:** Little Pee Dee River, 10 Jun 1956, *Radford 12493* (NCU). **Orangeburg Co.:** W of Orangeburg, 18 May 1957, *Ahles 25242* (NCU). **Richland Co.:** E of Ft. Jackson entrance, 13 May 1958, *Duke 529* (NCU). **Saluda Co.:** S of Ridge Spring, 26 May 1957, *Radford 23128* (NCU). **Sumter Co.:** N of Pinewood, 5 Jun 1957, *Radford 24011* (NCU). **Williamsburg Co.:** N of Mouzon, 12 Jun 1957, *Radford 24825* (NCU).—**VIRGINIA. Isle of Wight Co.:** S of Lees Mill, 29 May 1966, *Svenson 13932* (NCU*).

ACKNOWLEDGMENTS

We would like to thank the curators at GH, MICH, MIN, MSC, NY, P, US, and USF for providing specimen loans or digital images, and Carol Ann McCormick and Shanna Oberreiter (NCU) for assistance with databasing and curation of these collections. We are grateful to the Muséum National d'Histoire Naturelle (MNHN) – Paris Herbarium (P) for giving us permission to publish the digital image of an isotype of *Stipulicida setacea* from the Michaux Herbarium. We extend our appreciation to the UNC Chapel Hill Biology Department and UNC Herbarium (NCU) for providing resources to conduct this study. The quality of this manuscript was improved by the reviews of Richard Rabeler and Daniel Spaulding. This project was partially funded by the Charles T. Mohr Internship Fund of the UNC Herbarium / North Carolina Botanical Garden.

REFERENCES

Fior, S., P. Ola Karis, G. Casazza, L. Minuto, & F. Sala. 2006. Molecular phylogeny of the Caryophyllaceae (Caryophyllales) inferred from chloroplast *matK* and nuclear rDNA ITS sequences. Amer. J. Bot. 93:399–411.

Gill, F.B. 2014. Species taxonomy of birds: Which null hypothesis? The Auk 131:150–161.

Greenberg, A.K. & M.J. Donoghue. 2011. Molecular systematics and character evolution in Caryophyllaceae. Taxon 60:1637–1652.

Harbaugh, D.T., M. Nepokroeff, R.K. Rabeler, J. McNeill, E.A. Zimmer, & W.L. Wagner. 2010. A new lineage-based tribal classification of the family Caryophyllaceae. Int. J. Pl. Sci. 171:185–198.

James, C.W. 1957. A new variety of *Stipulicida setacea*. Rhodora 59:98.

Judd, W.S. 1983. The taxonomic status of *Stipulicida filiformis* (Caryophyllaceae). Sida 10:33–36.

Kartesz, J.T. 2013. *Taxonomic Data Center*. (http://www.bonap.net/tdc). The Biota of North America Program (BONAP). Chapel Hill, North Carolina, U.S.A. [maps generated from Kartesz, J.T. 2013. Floristic synthesis of North America, Version 1.0. Biota of North America Program (BONAP). (in press)]

Michaux, A. 1803. Flora Boreali-Americana. Vol. 1. Levrault, Paris, France.

Nash, G.V. 1895. Notes on some Florida plants. Bull. Torrey Bot. Club 22:141

Radford, A.E., H.E. Ahles, & C.R. Bell. 1968. Manual of the vascular flora of the Carolinas. University of North Carolina Press, Chapel Hill, North Carolina, U.S.A.

Small, J.K. 1903. Flora of the southeastern United States, being descriptions of the seed-plants, ferns and fern-allies growing naturally in North Carolina, South Carolina, Georgia, Florida, Tennessee, Alabama, Mississippi, Arkansas, Louisiana, and in Oklahoma and Texas east of the one hundredth meridian. Published by the author, New York, New York, U.S.A.

Small, J.K. 1913. Flora of the southeastern United States, being descriptions of the seed-plants, ferns and fern-allies growing naturally in North Carolina, South Carolina, Georgia, Florida, Tennessee, Alabama, Mississippi, Arkansas, Louisiana, and in Oklahoma and Texas east of the one hundredth meridian, second edition. Published by the author, New York, New York, U.S.A.

Small, J.K. 1933. Manual of the southeastern flora, being descriptions of the seed plants growing naturally in Florida, Alabama, Mississippi, eastern Louisiana, Tennessee, North Carolina, South Carolina, and Georgia. University of North Carolina Press, Chapel Hill, North Carolina, U.S.A.

Sorrie, B.A. & A.S. Weakley. 2001. Coastal Plain vascular plant endemics: Phytogeographic patterns. Castanea 66:50–82.

Sorrie, B.A. & A.S. Weakley. 2006. Conservation of the endangered *Pinus palustris* ecosystem based on Coastal Plain centres of plant endemism. Appl. Veg. Sci. 9:59–66.

Swanson, A. & R.K. Rabeler. 2005. *Stipulicida*. In: Flora of North America Editorial Committee, eds. Flora of North America north of Mexico. Vol. 5. Magnoliophyta: Caryophyllidae, part 2. Oxford University Press, New York, U.S.A. Pp. 27–28.

Ward, D.B. 2001. New combinations in the Florida flora. Novon 11:360–365.

Ward, D.B. 2012. New combinations in the Florida flora III. Phytologia 94:459–485.

Weakley, A.S. 2005. Change over time in our understanding of the flora of the southeastern United States: Implications for plant systematics, bioinformatics, and conservation. Ph.D. dissertation, Duke University, Nicholas School of the Environment and Earth Sciences, Durham, North Carolina, U.S.A.

Weakley, A.S. 2012. Flora of the southern and mid-Atlantic states, working draft of 30 November 2012. University of North Carolina Herbarium, Chapel Hill, North Carolina, U.S.A.

Wunderlin, R.P. & B.F. Hansen. 2008. Atlas of Florida vascular plants. www.plantatlas.usf.edu [S.M. Landry and K.N. Campbell (application development), Florida Center for Community Design and Research.] Institute for Systematic Botany, University of South Florida, Tampa, Florida, U.S.A. Accessed 28 Feb 2014.

Wunderlin, R.P. & B.F. Hansen. 2011. Guide to the vascular plants of Florida, third edition. University Press of Florida, Gainesville, Florida, U.S.A.

A NEW HEDGE-NETTLE (*STACHYS*: LAMIACEAE) FROM SOUTH CAROLINA, U.S.A.

John B. Nelson

A. C. Moore Herbarium
Department of Biological Sciences
University of South Carolina
Columbia, South Carolina 29208, U.S.A.

Douglas A. Rayner

Department of Biology
Wofford College
Spartanburg, South Carolina 29345, U.S.A.

ABSTRACT

A distinctive and geographically restricted species of *Stachys,* **S. caroliniana** (Lamiaceae), or "hedge-nettle," is described from South Carolina, as a member of the flora of the Coastal Plain of the southeastern U.S.A.

RESUMEN

Se describe del Carolina del Sur una especie distinta restringida geográficamente de *Stachys,* **S. caroliniana** (Lamiaceae), o "hedge-nettle," como miembro de la flora de la Llanura Costera de sureste de Estados Unidos.

Stachys is one of the larger genera of the subfamily Lamioideae within the Lamiaceae, encompassing nearly 300 species, and with a nearly cosmopolitan distribution, absent from Australia and the western Pacific (Epling 1934; Nelson 1981; Mulligan & Munro 1989). Its centers of species diversity include warm-temperate portions of western Asia and the Mediterranean, southern Africa, and portions of North and South America (İlçim et al. 2008). The genus in North America, north of Mexico, contains about 45 species, with species particularly concentrated west of the Rocky Mountains (especially in the Pacific states) and in the east along the Atlantic seaboard states and Appalachian region. Southeastern species occur in a wide variety of habitats, most often in mesic sites or wetlands, and at a wide variety of regional elevations. An additional species, known only from the Santee River delta of South Carolina, deserves recognition.

Stachys caroliniana J.B. Nelson & D.A. Rayner, sp. nov. (**Figs. 1–7**). TYPE: UNITED STATES. SOUTH CAROLINA. Georgetown Co.: grassy margin of freshwater pond, Cat Island, Tom Yawkey Wildlife Center, 7 Jul 2005, *J.B. Nelson 25466* (HOLOTYPE: USCH; ISOTYPES: BRIT, CLEMS, FSU, GH, NBYC, NCU, NY, US).

Stachys caroliniana differs from *S. pilosa, S. arenicola,* and *S. aspera* in having only short, dense stem pubescence on both stems sides and angles, the hairs of uniform size; in having shorter calyx lobes; and in having nearly white corollas.

Perennial **herbs,** with fibrous roots from pale, shallow rhizomes; **stems** strictly erect, to 0.5 m tall, scarcely branched except occasionally at lowest node of inflorescence (unless injured), the angles copiously short-hairy with stiff, short, reflexed or somewhat spreading hairs, the sides similarly pubescent, and also with rare, nearly sessile glandular hairs which become progressively more abundant upward; nodes slightly bearded; **leaves** nearly sessile, or the most basal, or largest midstem leaves with short petioles 2–5 mm; midstem leaves generally the largest, the blades 1–2(–2.5) cm broad, 2.5–6(–8) cm long; rounded to truncate at base, the lowest blades prominently obtuse-rounded apically, then progressively more acute distally along the stem; blades lanceolate, lance-elliptic; leaves spreading, upper surface abundantly pubescent or scaberulous with appressed non-glandular hairs, the hairs up to 1.5 mm, sharply pointed, uniformly distributed across the surface, the upper surface dark green, tending toward a dark bluish-green, especially in shade plants, or with an ashy-green appearance; lower surface pale green, copiously pubescent with erect, soft, sharp-pointed hairs to 1 mm, thus soft and "felty," the foliage when crushed without any particular fragrance; **inflorescence** a series of interrupted verticils, commonly elongated with age; **bracts** rapidly reduced upward from lowest fertile node (or in very robust flowering plants, more gradually reduced), the lowest bracts lanceolate, progressively trullate to ovate, pubescent with eglandular and glandular hairs; **axillary cymules** each with 3 flowers, the verticils thus

Fig. 1. Flowering stems of *Stachys caroliniana*. Photo by Jim Fowler.

Fig. 2. Open flowers at a single node of *Stachys caroliniana*. Photo by Jim Fowler.

6-flowered; bracteoles narrow, spinulose, glandular and pubescent, 0.5–0.8 mm long; flowers perfect and fertile; **calyx** campanulate, densely short-soft pubescent, with abundant delicate, stipitate glands; fruiting calyx 5.5–7 mm long, the tube (to base of lobe sinus) 3.5–4 mm, the lobes 2–3 mm; lobes abundantly hairy with eglandular and stipitate glands, especially along veins, deltoid to lanceolate, mostly ½ the length of the tubes, each lobe terminated by a pale apiculum; **corolla** tubular and galeate, from base to galea apex 13 mm long at full anthesis; corolla tube prominently saccate toward base on lower side, internally glabrous, but with prominently slanting (oblique) annulus, copiously pubescent with soft, bulbous trichomes; corollas white, scarcely pinkish, save for scattered spots on lower lip, the lower corolla lip declined up to 90° from tube, to 7 mm long, the central lobe nearly rotund, 4–5.5(–6) mm broad; filaments pink, with short, capitate glands as well as bulbous trichomes; **mericarps** 1–1.2 mm broad, 1.6–1.8 mm long, dark brown, minutely pebbled.

Additional collections examined: **UNITED STATES. South Carolina: Georgetown Co.:** first collection from type locality, 22 Jun 1990, *J.B. Nelson 9256* (USCH); same locality, 12 Aug 1993, *J.B. Nelson 14649 with C.N. Horn* (USCH). **Charleston Co.:** Santee Coastal Reserve, along old rice canal, 10 Aug 1977, *D.A. Rayner 1011* (USCH).

The first known collection of this plant is from Charleston County, South Carolina, on the south side of the Santee River within the Santee Coastal Reserve, collected by D.A. Rayner (*1011*, USCH 20756) in 1977, a unicate, which remained a questionable collection of *Stachys aspera* Michx. (as *Stachys hyssopifolia* Michx. var. *ambigua* Gray) for some time. The Santee Coastal Reserve is an extensively managed, large holding of land (nearly 24,000 acres) owned and administered by the South Carolina Department of Natural Resources (SCDNR). For decades, this property has been managed dynamically for wildlife habitat, although its 18th–19th Century history was devoted in considerable part to rice culture. The original population was located between pine

Fig. 3. Flowers in early fruit of *Stachys caroliniana*. Photo by Jim Fowler.

flatwoods and a freshwater marsh; this population has not been seen since its first collection. The same plant was collected again in 1990 in Georgetown County, in its only other known locality (the type locality), approximately 8 air miles (13 km) to the northeast of the first collection, this on the north side of the Santee River. This second site is 10.4 air miles (17 km) south of the city of Georgetown on the west-central part of Cat Island, within the Tom Yawkey Wildlife Center, also managed for wildlife by SCDNR, in Georgetown County (Nelson 2002). The site of the type collection is barely 0.4 miles (about 600 m) east of the Intracoastal Waterway. The Yawkey Center collection is in habitat similar to that of the Charleston County population, along the south side of the Santee River. [The watershed of the Santee River effectively drains nearly half of South Carolina: a common misconception is that the Savannah River is the major river system of South Carolina, when in fact its watershed is much more important—biologically and culturally—in neighboring Georgia (Edgar 1998)].

This taxon is instantly differentiated from all other taxa in the southeastern U.S.A. by its dense, short, uniform stem pubescence, its relatively short calyx lobes, and its white corollas. The other species of *Stachys*

Fig. 4. Midstem leaves and stem of *Stachys caroliniana*. Photo by Jim Fowler.

known to occur in Charleston and Georgetown counties are the two relatively uncommon natives *S. aspera* and *S. tenuifolia*, as well as the widespread and weedy *S. floridana*. These three sympatric taxa, as well as others, are discussed below.

Stachys aspera Michx. is a wide-ranging species, from northern Florida north into Maryland, and including scattered sites in the upper Midwest, and as far south as Missouri. The type (P!) was presumably collected by Andre Michaux in Charleston County, within which modern locations are still known (e.g., *Nelson 10849*, USCH, collected 25 Jul 2001, which incidentally agrees well with the type at P) as well as slightly more distant counties (e.g., Dorchester, *Nelson 25149*; Berkeley, *Nelson 30626*, *Porcher 2457b;* Colleton, *Bourgeois s.n.*, July 2009, all USCH). *Stachys aspera* is a potentially tall (stems over 1 m, although usually much shorter) perennial, the stems commonly sprawling and supported by other vegetation. Its stems are typically glabrous on the sides, with glabrate to hispid angles. Its leaves are generally lanceolate to narrowly elliptic and although hairy (glabrate to hispidulous/hispid), are never soft and felt-like to the touch. Its corollas are pink. The mature calyx lobes tend to be straight or barely spreading. Although distinctive in South Carolina, *S. aspera* is clearly related to *S. hispida* Pursh from farther north. The separation of these two taxa throughout their range is not straightforward, and there is some discussion concerning their conspecificity.

Stachys tenuifolia is an even more widespread species, known on the Coastal Plain from the Gulf Coast (eastern Texas) to New Jersey, most commonly in considerable shade along river bottoms along the lower Mississippi and its upper tributaries, well into Arkansas, Oklahoma, Missouri, Iowa, Illinois, Indiana, Ohio,

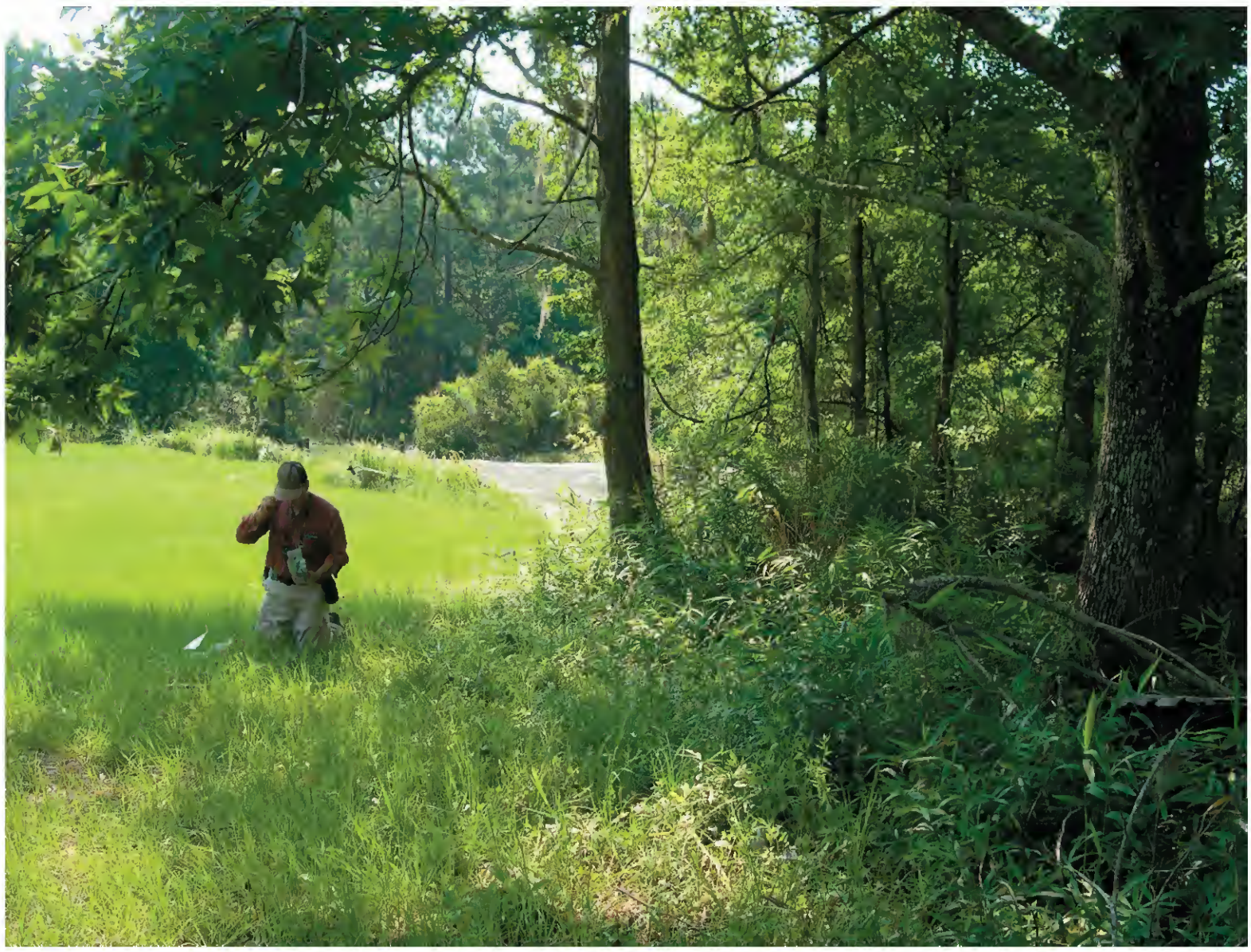


Fig. 5. Habitat at type locality of *Stachys caroliniana*, John Cely pictured. Photo by John Nelson.

and West Virginia and is known additionally from a number of upland, "interior" sites. This is a variable taxon, most often with glabrous/glabrate stems, these not infrequently slightly retrorse-hispidulous. This taxon always features prominently petioled leaves with blades which are lanceolate or elliptical, and usually with strongly serrated margins, with the plants commonly branching well below the first fertile node. Its corollas are distinctly pink. Calyx lobes of *S. tenuifolia*, in fruit, are commonly curled backward. *Stachys tenuifolia* has also been regarded as a near relative of *S. hispida*, the two taxa sometimes intergrading (Cooperrider & Sabo 1969).

Stachys floridana similarly has pink corollas, as well as prominently petioled leaves which are crenate (to serrate) on the blade margins, and commonly cordate at the base. Plants commonly produce crisp, somewhat swollen, bulbous, moniliform rhizomes (which are edible). This is the earliest-flowering perennial species known in the southeastern U.S.A., sometimes blooming in early April on the Coastal Plain of South Carolina, and has earned considerable notoriety as an aggressive weed. Above-ground short systems commonly senesce and die by early June, normally disappearing entirely by late summer.

There is no question that the plant from Charleston and Georgetown Counties, South Carolina, is distinctive from all other commonly known southeastern taxa. The only other possibility of close taxonomic relationships involves those with *Stachys pilosa* Nuttall and *Stachys arenicola* Britton, the ranges of which are considerably far removed from *S. caroliniana*.

Stachys pilosa is an extremely variable and softly hairy plant, occurring from Ontario into much of the American Midwest, which surely represents the broadest distribution of any North American *Stachys*; it is not a part of the flora of the southeastern U.S.A. Its stems feature long, spreading hairs on the angles and usually at

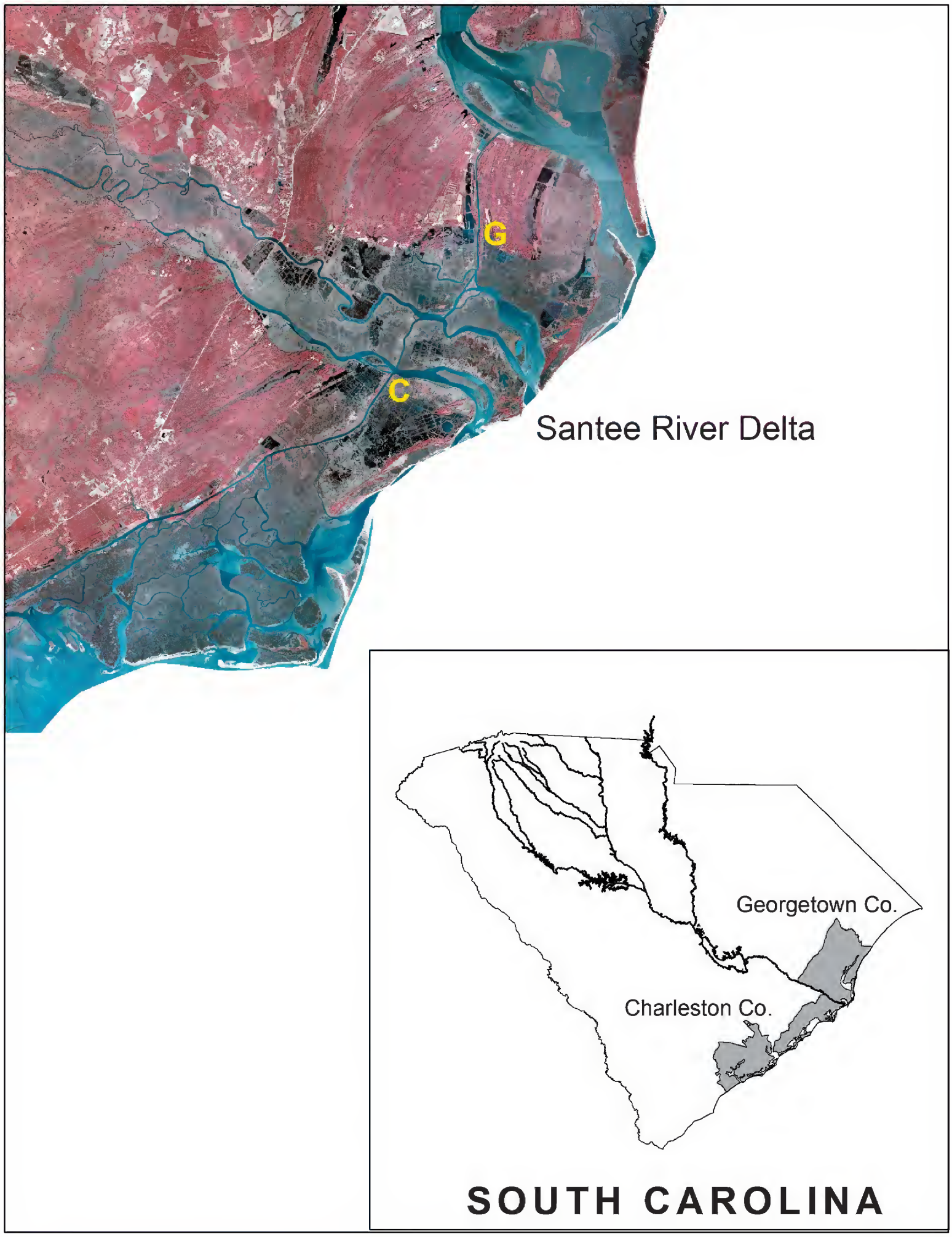


Fig. 6. Location of known populations of *Stachys caroliniana*. G = Georgetown County (type locality), C = Charleston County, Rayner collection (approximate). Inset map indicates borders of South Carolina, Georgetown County, Charleston County, and the drainage of the Santee River.

Fig. 7. Holotype of *Stachys caroliniana* (*Nelson 25466*).

least a "subcanopy" of glandular and eglandular hairs on the sides, commonly forming a two-tiered appearance. *Stachys pilosa* has pink corollas, featuring a lance-oblong lower lip commonly notched distally.

Stachys arenicola, similarly with pink corollas, was described by Britton from plants with coarsely scabrous stems and foliage, the stems featuring both coarse and fine eglandular hairs, these predominantly downwardly angled, on the angles as well as the sides. Its southernmost occurrences are apparently in Virginia (Prince William County, *Fleming 7164, 13408, 13414* [USCH]; Frederick County, *Nelson 13174* USCH).

Stachys pilosa, as widespread as it is and as a frequent resident of wet prairies, could conceivably be transported by waterfowl along migratory flyways from more northern sites into the Southeast; the same is at least marginally true for *Stachys arenicola*. And, the South Carolina sites discussed so far within this article have historically had heavy visitation by migratory waterfowl. *Stachys caroliniana*, however, is narrowly restricted in its range and apparently so differentiated morphologically that its conspecific status with either *S. pilosa* or *S. arenicola* is most unlikely.

KEY TO *STACHYS CAROLINIANA* AND ITS GEOGRAPHIC AND MORPHOLOGIC RELATIVES

1. Leaves with well-developed petioles ⅕ (or longer) the length of the blade; summer or spring-blooming.
   2. Plants with slender rhizomes; stem side glabrous (rarely glabrate); stem angles glabrate (rarely hairier); blade bases rounded; calyx glabrous to hispidulous, without glandular hairs; summer blooming _____ **S. tenuifolia**
   2. Plants with swollen, crisp, moniliform tubers; stem angles hispidulous to hirsute with reflexed hairs; blade base truncate to cordate; calyx abundantly pubescent with glandular and eglandular hairs; spring blooming _____ **S. floridana**
1. Leaves sessile or with petioles less than ⅕ length of blade; summer blooming.
   3. Stem sides glabrous (to glabrescent) _____ **S. aspera**
   3. Stem sides abundantly pubescent, tomentulose, hispidulous, or hispid.
      4. Corollas pink; calyx lobes ½ the length of calyx tube; lower leaf blades acute-acuminate; lower lip of corolla ovate to lance-ovate; VA and north.
         5. Leaf blades elliptic; hairs of stem angles and sides spreading, with stipitate glands on sides _____ **S. pilosa**
         5. Leaf blades lanceolate; hairs of stem angles and sides retrorse (spreading), without stipitate glands _____ **S. arenicola**
      4. Corollas white; calyx lobes < ½ length of calyx tube; lower leaf blades obtuse; lower lip of corolla rotund-ovate; endemic to SC _____ **S. caroliniana**

In spite of the large amount of acreage along the Atlantic Seaboard (New York to Florida) which more or less duplicates landscape features of the Santee River delta in South Carolina, no other collections of this hedge-nettle are known: indeed, its morphology is distinctive and unique. Despite the relatively high amount of botanical interest in and around this area, both historic and recent, only two collections—and populations—are known. The two populations are apparently from presumably similar habitats, and they are relatively near each other. They are not weedy plants and not represented from other places by known herbarium collections. *Stachys caroliniana* is here proposed as occurring in relict populations and should be considered very rare and probably in danger of extinction.

Etymology.—Known only from South Carolina, the epithet "*caroliniana*" is chosen to reflect its natural and only known home to date.

ACKNOWLEDGMENTS

We are grateful to the administrators and personnel of the South Carolina Department of Natural Resources for access to The Santee Coastal Reserve and the Tom Yawkey Wildlife Center, with special appreciation for the help, respectively, of Tommy Strange and Bob Joyner. Field efforts at the Yawkey Center site were augmented by the assistance of Devin Kennemore (USCH), Charles Horn (NBYC), and more recently by Bert Pittman, John Cely, and Jamie Dozier (all SCDNR). Herrick Brown (USCH) provided valuable assistance in designing our figures. We thank Jim Fowler, of Greenville, SC, for the excellent photographs of *Stachys caroliniana*. Our manuscript was improved by the suggestions offered by Gary Fleming (VA Natural Heritage), Derick Poindexter (NCU), and Michael Vincent (MU). Publication costs for this paper were defrayed by the W.T. Batson Endowment for the A.C. Moore Herbarium at the University of South Carolina.

REFERENCES

Cooperrider, T.S. & R.F. Sabo. 1969. *Stachys hispida* and *S. tenuifolia* in Ohio. Castanea 34:432–435.

Edgar, W.T. 1998. South Carolina: A history. University of South Carolina Press, Columbia, U.S.A.

Epling, C.C. 1934. Preliminary revision of American *Stachys*. Repert. Spec. Nov. Regni Veg. 80:1–75.

İlçim, A., M. Çenet, & M.Y. Dadandi. 2008. *Stachys marashica* (Lamiaceae), a new species from Turkey. Ann. Bot. Fennici 45:151–155.

Mulligan G.A. & D.B. Munro. 1989. Taxonomy of North American species of *Stachys* (Labiatae) found north of Mexico. Naturaliste Can. 116:35–51.

Nelson, J.B. 1981. *Stachys* in southeastern United States. Sida 9:104–123.

Nelson, J.B. 2002. Floristic and Landscape Inventory of Tom Yawkey Wildlife Center, Georgetown County, South Carolina. Unpublished final report: Tom Yawkey Foundation.

AGAVE × *MADRENSIS* (ASPARAGACEAE), A PUTATIVE HYBRID FROM THE SIERRA MADRE ORIENTAL, MEXICO

José A. Villarreal Quintanilla and Abraham Ramírez Gámez

Universidad Autónoma Agraria Antonio Narro
Departamento de Botánica
Buenavista, Saltillo 25315, Coahuila, MÉXICO
javillarreal00@hotmail.com
ica_ab.ram@hotmail.com

Eduardo Estrada Castillón

Facultad de Ciencias Forestales
Universidad Autónoma de Nuevo León
Apartado postal 41
Linares, 67700, Nuevo León, MÉXICO
aeduardoestradac@prodigy.net.mx

Dino U. González Uribe

Universidad Autónoma Agraria Antonio Narro
Departamento de Estadística y Cálculo
Buenavista, Saltillo 25315, Coahuila, MÉXICO
digon_mx@yahoo.com

Diana Jasso de Rodríguez

Universidad Autónoma Agraria Antonio Narro
Departamento de Fitomejoramiento
Buenavista, Saltillo 25315, Coahuila, MÉXICO

ABSTRACT

A putative hybrid in *Agave* is described and illustrated from southern Nuevo Leon state in Mexico. **Agave × madrensis** is believed to be a natural, crossbreeding hybrid between *Agave gentryi* and *Agave lechuguilla*. A morphometric analysis between the parental species and the hybrid was created to assess the parentage of the individuals in question. A multivariate analysis (MANOVA) and a discriminant analysis are used to support the hypothesis of the existence of a natural occurrence of this hybrid. Plant illustrations are included.

Key Words: *Agave* × *madrensis*, Asparagaceae, Nuevo León, México, hybridization, morphometric analysis

RESUMEN

Se describe un supuesto híbrido en *Agave* con material proveniente del sur del estado de Nuevo León, México. **Agave × madrensis** se cree es un cruzamiento natural entre *Agave gentryi* y *Agave lechuguilla*. Se realizó un análisis morfométrico de las especies involucradas para evaluar la posible relación en el parentesco del hibrido. Un análisis multivariado (MANOVA) y uno discriminante se usan para apoyar la hipótesis de la existencia de un híbrido natural intermedio entre las especies parentales. Se incluyen ilustraciones de la planta.

Agave is a genus endemic to America. It has approximately 200 species and 247 taxa, of which 75 per cent are found in Mexico, most of them growing in arid and semiarid regions (García 2002). Natural hybridization is not rare in *Agave* (Gentry 1967), as shown below. Hybrids are known in elements of the same subgenus, as in *A. nickelsiae* Gosselin and *A. lechuguilla* Torr., both of subgenus *Littaea* (González et al. 2011), but are more frequent between species of different subgenera, as in *A. marmorata* Roezl (subg. *Agave*) and *A. kerchovei* Lem. (subg. *Littaea*) of central Mexico (Valverde et al. 1996), *A. asperrima* Jacobi (subg. *Agave*) and *A. nickelsiae* Gosselin (subg. *Littaea*) (Gentry 1982; González et al. 2011) and *A. asperrima* Jacobi (subg. *Agave*) and *A. victoria-reginae* T. Moore (subg. *Littaea*) both from northern Mexico (Verduzco et al. 2009). Most of them were described at the specific level. Several putative hybrids are also known from the southwestern United States and include *A.* × *arizonica* Gentry & J.H. Weber, *A.* × *ajoensis* W.C. Hodgs. and probably *A. schottii* Engelm. var. *treleasei* (Toumey) Kearney & Peebles (Reveal & Hodgson 2001).

Sixteen taxa are reported to occur in Nuevo Leon (Villarreal & Estrada 2008). A recent collection from the Sierra Madre Oriental of Mexico included a specimen of *Agave* that is morphologically unlike any known species. Plants with large leaves and a racemose inflorescence led us to the idea of hybridization between *Agave gentryi* and *A. lechuguilla*, the only two species growing in the area. As both species are frequent in the mountains of north and central Mexico and the probability of a potential hybrid between them is present, the hybrid deserves to be named and recognized as a taxonomic element. A statistical analysis of morphometric traits was

Table 1. Means and standard deviations of the characters used in the morphometric study.

	A. lechuguilla	*A. gentryi*	putative hybrid
Plant diameter (d)	68.600±5.621	248.100±18.935	131.667±10.408
Leaf length (ll)	40.900±4.483	84.800±9.601	65.000±15.000
Leaf width (lw)	2.960±0.212	16.500±1.958	10.333±1.528
Number of leaves (nl)	39.200±5.116	48.500±6.346	49.000±7.937
Spines distance (sd)	1.840±0.196	3.380±0.319	2.467±0.503
Number of spines (ns)	15.400±2.171	30.300±3.622	14.667±2.517
Terminal spine length (tsl)	1.560±0.232	7.270±0.460	3.333±0.577
Valvedrian distance (vd)*	2.390±0.614	12.000±3.197	9.667±1.528
Inflorescence length (il)	1.170±1.526	2.250±3.631	5.333±4.726
Inflorescence width (iw)	4.700±6.075	42.300±68.131	23.333±20.817

*valverdian distance = distance between the upper spine and the terminal spine

Table 2. Means and standard deviations of the ratios used in the morphometric analysis.

	A. lechuguilla	*A. gentryi*	putative hybrid
Plant diameter/number leaves	4.530±0.695	8.288±1.087	9.078±0.885
Leaf length/width	13.853±1.602	5.211±0.889	6.241±0.599
Spines number/distance	8.395±1.016	9.097±1.787	5.972±0.293
Terminal spine length/ valverdian distance*	0.701±0.233	0.669±0.277	0.293±0.346
Inflorescence length/width	1.358±1.785	0.184±0.297	1.431±1.344

*valverdian distance = distance between the upper spine and the terminal spine

used to test the hypothesis that a hybrid should be expected to be morphologically intermediate between the putative parents.

MATERIALS AND METHODS

Ten plants belonging to each parental species were randomly selected in two populations in the area, and three plants of the putative hybrid. Three leaves were evaluated and the average computed for each individual. The morphometric measures are: rosette diameter (d), number of leaves (nl), leaf length (ll), leaf width (lw), number of spines by side (ns), distance between spines (ds), terminal spine length (tsl), and distance between the last and the terminal spine–valverdian distance (vd). The length (il) and width (iw) of three inflorescences of parental and putative hybrid were included.

The data were statistically evaluated by a discriminant analysis using a multivariate analysis (MANOVA) with the Wilk's test (Everitt & Hothorn 2010), included in the PAST software, version 2.01 (Hammer & Harper 2006).

RESULTS

Means and standard deviations of the characters used in the morphometric study are shown in the Table 1. Five character means (leaf length, leaf width, number of leaves, valverdian distance and inflorescence length) are closer to *Agave gentry*, while four (plant diameter, spines distance, number of spines and the terminal spine length) are for *A. lechuguilla*; and one (inflorescence width) is intermediate between both species. Seven means of the putative hybrids lay between the means of the parental species, and three (number of leaves, number of spines and inflorescence length) are slightly exceeded from a parental mean.

The ratios and standard deviation used in the discriminant analysis are shown in the Table 2. The plot derived from the analysis (Fig. 1) includes three groups clearly separated in the discriminant space. It can be concluded that the ratios of *A. lechuguilla* and *A.gentryi* are different and the putative hybrid is intermediate, according the Wilk's test ($p < 0.001$) with a Wilk's Lambda = 0.01692. However, direct breeding studies are

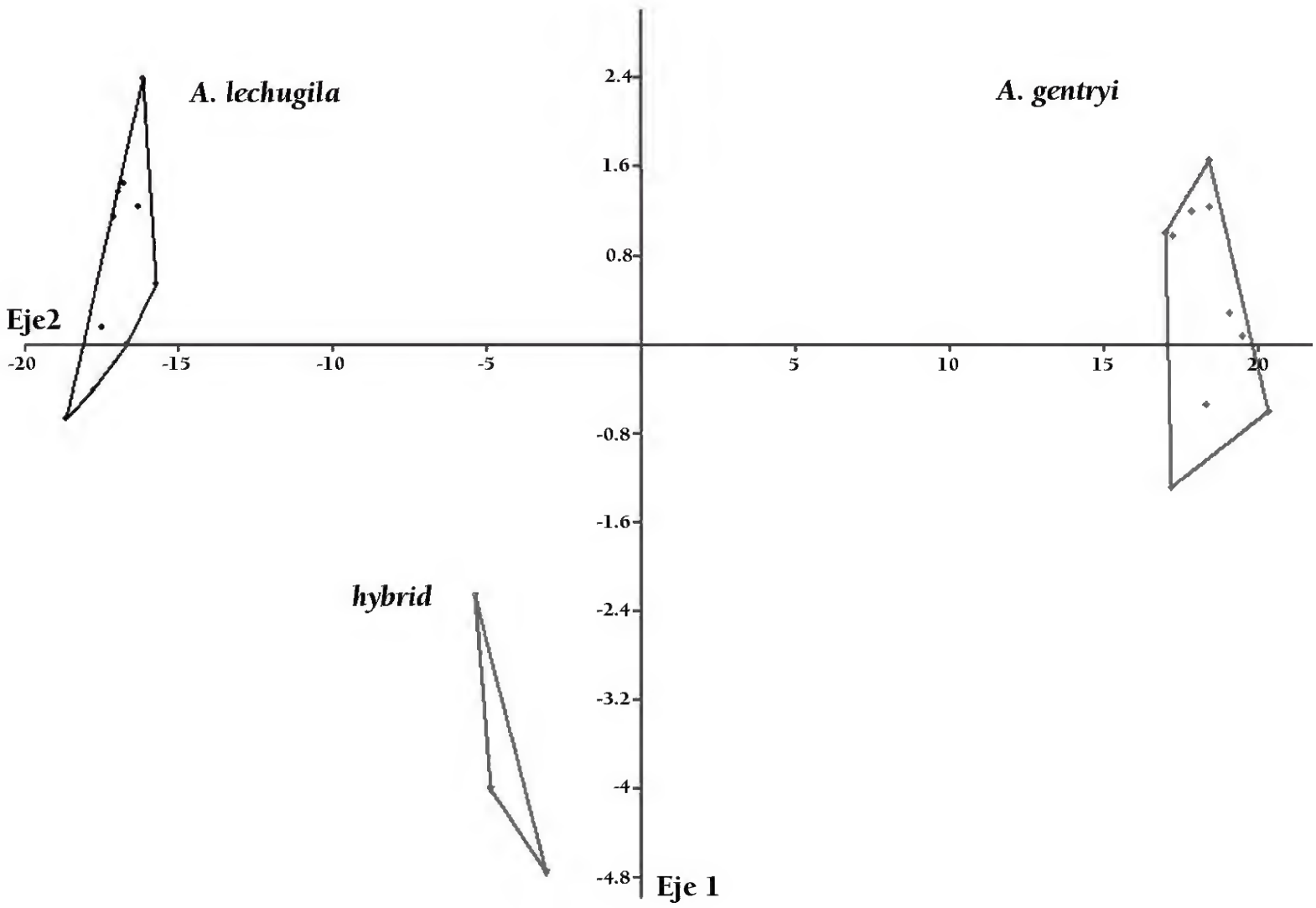


Fig. 1. Plot that shows the results of the use of the Discriminant analysis applied to the five morphometric ratios listed in the Table 2.

needed for more conclusive evidence. As the two parental species belong to different subgenera we are considering that the plant is a putative intersubgeneric hybrid and is described as a new taxonomic entity.

Agave × madrensis Villarreal, A. Ramírez, & A.E. Estrada, hybrid nov. (**Figs. 2–3**). Type: MÉXICO. Nuevo León: Municipio de Galeana, cerro El Potosí, camino a las antenas. Bosque esparcido de *Pinus hartwegii* y encinar enano, 2654 m, 21 Aug 2012, *A. Ramírez 106* (holotipo: MEXU; isotypes: ANSM, CFNL, ENCB, TEX; to be distributed).

Similar to *Agave montium-sancticaroli* García-Mend., but with lanceolate leaves 50–80 cm long, inflorescence 7–9 m long with 80–150 floriferous branches and distribution in the Sierra Madre Oriental.

Perennial single plants, acaulescent, moderately suckering; rosettes hemispheric, openly spreading, 120–140 cm wide, 80–100 cm high. Leaves 40–55 per plant, lanceolate, concave toward apex, 50–80 cm long, 9–12 cm wide, ascending, glaucous to green-yellowish when mature, the base slightly enlarged, the apex acuminate, the margins straight, the terminal spine 3–4 cm long and 6–7 mm wide at the base, brown, the marginal teeth 12–17 pairs, straight to slightly retrorse, 2–3 cm apart, 4–7 mm high, brown. Flowering stalk 7–9 m tall, the inflorescence a racemose panicle, congested, largely oblong (fusiform), 4–5 m long and 30–40 cm wide, the peduncles 8–12 cm diameter, bracteates; bracts long triangular, 20–28 long, 5–6 cm wide at the base, chartaceous, the margins entire, the apex with a short and weak spine; branches of the inflorescence 15–20 cm long, spaced 10–15(–20) cm apart, green-purple; bracts like those of the peduncle, largely triangular, 12–18 cm long. Flowers 18–26 per umbel, 5–6 cm long, narrowly campanulate, succulent, green-yellowish, flushed with purple; pedicels 4–12 mm long; tepal lobes largely triangular,18–20 mm long, 3–5 mm wide, succulent, the outer ones slightly larger than the inner, the margins involute, the apex cucullate; floral tubes 5–6 mm long, 7–10 mm diameter distally, slightly sulcate; filaments 45–55 mm long, inserted above mid-tube (3–4 mm), yellowish distally flushed with purple; anthers dorsifixed, 20–25 mm long, 2 mm wide, yellow; ovary cylindric, 20–26 mm long, 6–8 mm wide, green, the neck 2–4 mm long, the style 5–6 cm long, the stigma

Fig. 2. *Agave* × *madrensis*. **A.** Flowering plant. **B.** Rosette of leaves. **C.** Inflorescence close-up. **D.** Close-up of flowers and pollinators. Photos by A. Ramírez G.

claviform,trilobate. Capsules oblong to slightly ovate, 4–6 cm long and 20–25 mm wide, rostrate, dark brown; seeds lunulate, flattened, 5–6 mm long, 4–5 mm wide, black.

Distribution and ecology.—The plant grows in southern Nuevo Leon state on steep slopes in limestone soils, at 2500 to 2700 m. The area is dominated by a dwarf oak community, mainly of *Quercus greggii*, and other shrubs such as *Arctostaphylos pungens*, *Arbutus xalapensis*, *Ceanothus buxifolius*, *Pinus culminicola*, *Cercocarpus* sp., and *Agave gentryi*, with sparse forest components of *Pinus hartwegii* and *Pseudotsuga menziesii*. Additional immature specimens believed to be conspecific were observed, considering a probable wider distribution, possibly tracking the occurrence of *Agave gentryi* in the Sierra Madre Oriental. Four plants were found in the area, all of them close to a roadside, as might be expected of an association with disturbance. The incidence of hybrids in disturbed environment was discussed by Grant (1971).

Phenology.—Flowering during the summer, fruiting at the end of summer and beginning of autumn.

Etymology.—The specific epithet refers to the Sierra Madre Oriental where the plant is distributed.

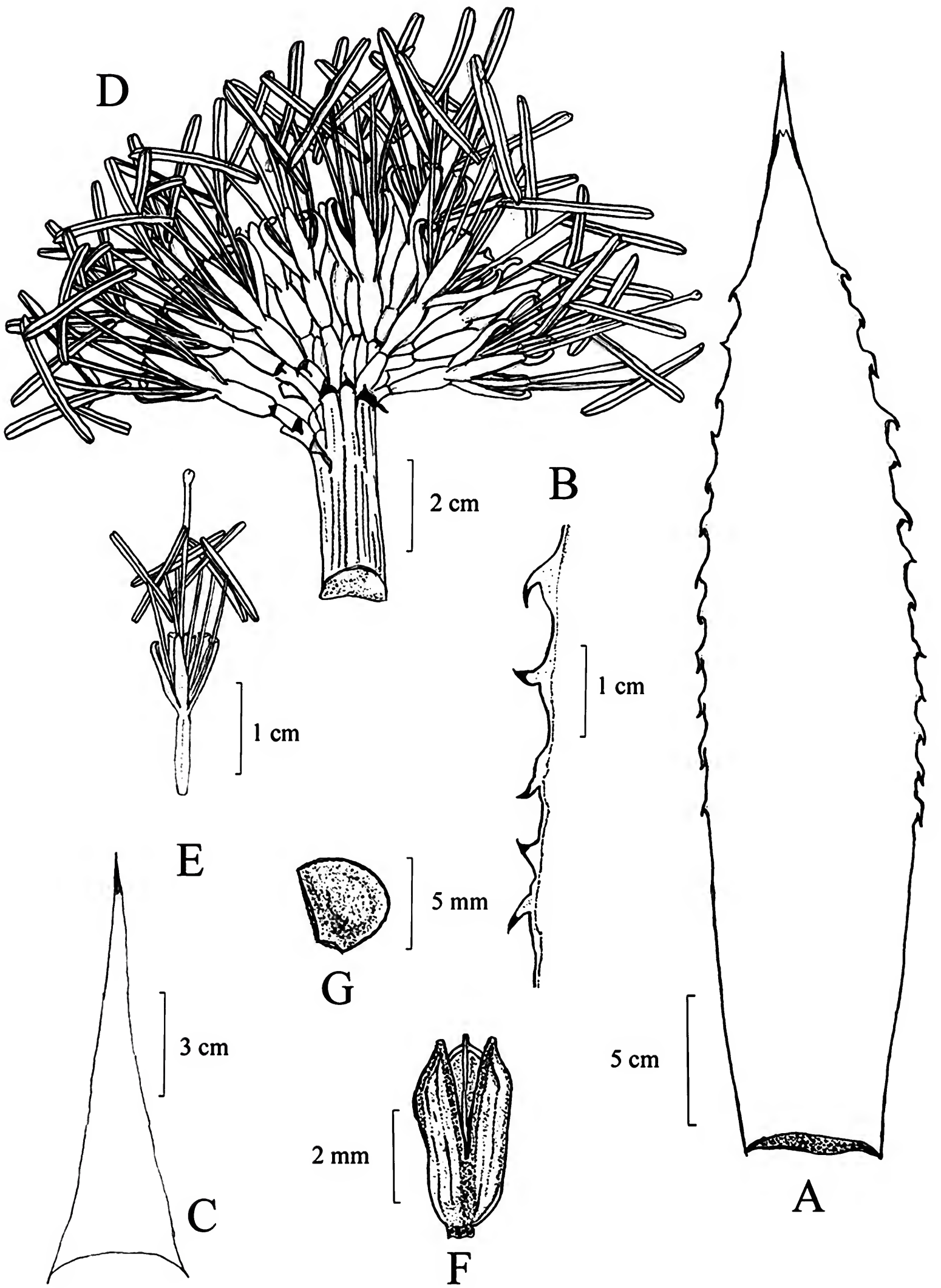


Fig. 3. *Agave* × *madrensis*. **A.** Leaf. **B.** Leaf margin. **C.** Bract. **D.** Cluster of flowers. **E.** Flower. **F.** Fruit. **G.** Seed.

Table 3. Comparison of select character states of *Agave* × *madrensis*, *A. gentryi*, *A. lechuguilla*, and *A. montium-sancticaroli*.

Character	*A.* × *madrensis*	*A.gentryi*	*A. lechuguilla*	*A. montium-sancticaroli*
Leaf length	50–80 cm	60–100 cm	25–50 cm	100–120 cm
Leaf shape	lanceolate	triangular	linear-lanceolate	linear-lanceolate
Leaves/plant	40–55	30–45	30–45	50–80(100)
Flower stalk	7–9 m	3–5 m	2.5–3.5 m	5.5–7 m
Infl. length	⅗	⅓–½	⅓–¼	½–⅚
Infl. shape	fusiform	elliptic	cylindrical	fusiform
Infl. branches	80–150	16–20	80–120	60–80(140)
Branch length	15–20 cm	50–80 cm	4–6 mm	8–13 cm
Flower length	50–60 mm	70–90 mm	30–45 mm	40–50(–60) mm
Distribution	SMO	SMO	CDR	LLCG y SSC

SMO = Sierra Madre Oriental, CDR = Chihuahuan Desert Region, LLCG = Llanura Costera del Golfo, SSC = Sierra de San Carlos.

The plants exhibit an inflorescence morphology which is intermediate between the broad panicles of subg. *Agave* with many-flowered partial inflorescences (branches), and the narrow-elongate, spike-like inflorescences of subg. *Littaea* with few-flowered partial inflorescences (branches), as shown in the Table 3. The plant seems to represent a natural hybrid between a member of subg. *Agave* (the sympatric *A. gentry* B. Ullrich) and a member of subg. *Littaea* (*A. lechuguilla* Torr.).

The plant is morphologically similar to *A. montium-sancticaroli* García-Mend. from Tamaulipas (García et al. 2007). Both have a similar racemose paniculate inflorescence, but *A.* × *madrensis* differs by the shape and size of the leaves (see Table 3), lack of small interstitial teeth between the large teeth found in *A. montium-sancticaroli*, peduncular bracts 20–26 cm long (vs. 11–16 cm) (Table 1), and occurring in the Sierra Madre Oriental (vs. between Llanura Costera del Golfo and Sierra de San Carlos), at 2500–2700 m (vs. 150–800 m) in forest to oak scrubland habitat (vs. tamaulipan thornscrub habitat). *Agave montium-sancticaroli* is published at the rank of species, but exhibits intermediate inflorescence morphology and might also represents a natural hybrid between *A. angustifolia* Haw. and *A. lophantha* Schiede ex Kunth. In the protologue, *A. montium-sancticaroli* is compared to A. × *glomeruliflora* (Engelm.) A. Berger, the latter suggested to be a series of hybrids involving *A. lechuguilla* Torr. of subg. *Littaea* and *A. gracilipes* Trel., *A. havardiana* Trel. and *A. parryi* Engelm. var. *neomexicana* (Wooton & Standl.) McKechnie of subg. *Agave* (Gentry 1982). *Agave lechuguilla* is considered a "dono-species" by Gentry (1967), hybridizing with several other taxa.

ACKNOWLEDGMENTS

We thank Wendy C. Hodgson and anonymous reviewer for their comments and suggestions to improve the manuscript. We are grateful to the Consejo Nacional de Ciencia y Tecnología for the financial support through the scholarship 369816 and to the Universidad Autónoma Agraria Antonio Narro through research project 36142227.

REFERENCES

Everitt, B. & T. Hothorn. 2010. A handbook of statistical analyses using R. 2nd ed. CRC Press, Boca Raton, Florida, U.S.A.

Gentry, H.S. 1967. Putative hybrids in *Agave*. J. Heredity 58(1):32–36.

Gentry, H.S. 1982. Agaves of continental North America. University of Arizona Press, Tucson, Arizona, U.S.A.

García M., A. 2002. Distribution of the genus *Agave* (Agavaceae) and its endemic species in Mexico. Cactus Succ. J. (Los Angeles) 74:177–187.

García M., A.J., C. Jacques H., & A. Salazar B. 2007. Una nueva especie de *Agave* subgénero *Littaea* (Agavaceae) de Tamaulipas, México. J. Bot. Res. Inst. Texas 1(1):79–84.

González E., M.S., M. González E., I.L. López E., L. Rezéndiz R., J.A. Tena F., & F.L. Retana R. 2011. El complejo *Agave victoria-reginae* (Agavaceae). Acta Bot. Mex. 95:65–94.

Grant, V. 1971. Plant speciation. Columbia University Press, New York, New York, U.S.A.

Hammer, Ø. & D.A.T. Harper. 2006. Paleontological data analysis. Blackwell Publishing, Malden, Massachusetts, U.S.A.

Reveal, J. L. & W.C. Hodgson. 2001. *Agave*. In: Flora of North America Editorial Committee, eds. 1993 +. Flora of North America North of Mexico. 16+ vols. New York & Oxford. 26:442.

Valverde, P.L., F. Vite, & J.A. Zavala H. 1996. A morphometric analysis of a putative hybrid between *Agave marmorata* Roezl and *A. kerchovei* Lem.: *Agave peacockii* Croucher. Bot. J. Linn. Soc. 122(2):155–161.

Verduzco M., J., C.L. Predo R., & R. Mercado H. 2009. Caracterización e identificación taxonómica del maguey. Memorias del VII Simposium-Taller Producción y Aprovechamiento del Nopal en el Noreste de México. Revista Salud Pública y Nutrición 2:75–90.

Villarreal Q., J.A. & E. Estrada C. 2008. Listados florísticos de México. XXIV. Flora de Nuevo León. Instituto de Biología, Universidad Nacional Autónoma de México. México D.F.

BOOK REVIEW

GEYATA AJILVSGI. 2013. **Butterfly Gardening for Texas.** (ISBN-13: 978-1-60344-806-2, flex-bound). Texas A&M University Press, 4354 TAMU, College Station, Texas 77843-4354, U.S.A. (**Orders:** www.tamupress.com, 1-800-826-8911). $35.00, 448 pp., 268 color photos, 11 line art, 2 maps, 17 tables, 8.5" × 11".

This work substantially updates the author's 1990 *Butterfly Gardening for the South* with special attention to the needs and interests of Texas gardeners, beginning with the hardiness zone and vegetational maps on the inside of the covers and end pages. The coverage of butterflies indicates all stages from egg to adult, flight time, and overwintering details. For both larval host plants and for nectar plants, the author features native plants with occasional non-natives, such as *Pentas* spp. and *Buddleia davidii* for nectaring butterflies as well as enhancements for the garden. Colored photos of plants and butterflies and tables of plants, bloom times, and height add to the usefulness of the book. This is a better, more complete book than the earlier one, though the flex-binding may not be as durable as the original hardbound one.—*Joann Karges, Texas Christian University Library (retired), Fort Worth, Texas, U.S.A.*

GEYATA AJILVSGI writes and photographs from her home in the Hill Country. Considered among the state's top plant and butterfly experts, she is the author of Wild Flowers of Texas and other books.

BOOK NOTICE

NOAH WILSON-RICH WITH CONTRIBUTIONS FROM KELLY ALLIN, NORMAN CARRECK, AND ANDREA QUIGLEY. 2014. **The Bee: A Natural History.** (ISBN-13: 978-0-69116-135-8, hbk.). Princeton University Press, 41 William St., Princeton, New Jersey, 08540-5237, U.S.A. (**Orders:** http://press.princeton.edu). $27.95, 224 pp., illustrated, 8" × 9".

From the Publisher: The Bee: A Natural History (September 10, 2014) by Noah Wilson-Rich is the most accessible source of information about all bee species, written for non-scientists by some of the world's leading bee experts and researchers. Beautiful artwork complements and clarifies the text, which is kept brief enough to cover as much information as possible, while keeping general readers engaged.

A review is forthcoming!

DOS NUEVAS ESPECIES DE *MYRCIA* (MYRTACEAE), DEL PACÍFICO SUR DE COSTA RICA

Daniel Santamaria Aguilar

Dirección Actual: Harvard University Herbaria
22 Divinity Avenue
Cambridge, Massachusetts 02138–2020, U.S.A.
daniel.santamaria366@gmail.com

Armando Estrada Ch.

Museo Nacional de Costa Rica
Apartado Postal 749-1000
San José, COSTA RICA
aestrada@museocostarica.go.cr

Reinaldo Aguilar

Los Charcos de Osa, Centro de
Diversidad de Plantas Regionales
Apartado Postal 76-8203
Península de Osa, Puntarenas, COSTA RICA

RESUMEN

Se describen e ilustran dos nuevas especies de *Myrcia*: **Myrcia paulii-jonesii** y **Myrcia riverae,** endémicas de Costa Rica. Se comentan sus afinidades, distribución, fenología y hábitat.

ABSTRACT

Two new species of *Myrcia* endemic to Costa Rica are described and illustrated: **Myrcia paulii-jonesii** and **Myrcia riverae.** Their affinities, distribution, phenology, and habitat are discussed.

Myrcia DC. es uno de los géneros más diversos y complejos de la familia Myrtaceae, con alrededor de 350 especies y una amplia distribución en América tropical y subtropical (Lucas et al. 2011; Parra-O 2013). Se distingue de los otros géneros de la familia por sus inflorescencias paniculadas, las flores con el cáliz abierto en botón, con cinco sépalos distintos (raro 4), persistentes, ovario con 2 ó 3 (–4) lóculos, 2 óvulos por lóculo y las semillas 1 ó 2, con el embrión myrcioide (Holst & Kawasaki 2007; Lucas et al. 2011).

El género fue subdividido por McVaugh (1969) en las secciones *Aulomyrcia* (O. Berg) Griseb., *Armeriela* McVaugh y *Myrcia*, de las cuales solo la sección *Myrcia* ha resultado monofilética (Lucas et al. 2011). Por otra parte, el género *Gomidesia* O. Berg, un grupo numeroso de especies suramericanas con indumento pardo-rojizo o ferrugíneo, lobos del cáliz truncados y anteras con tecas desplazadas o reflexas (McVaugh 1968; Holst & Kawasaki 2009; Nic Lughadah et al. 2010), es actualmente incluido dentro de *Myrcia* respaldado por estudios moleculares recientes, los cuales sugieren además que nueva clasificación subgenérica es requerida (Holst & Kawasaki 2009; Lucas et al. 2011).

En Costa Rica el género está representado por ocho especies (sin incluir las dos aquí descritas), aunque se indica que algunas de estas entidades son tentativas o bien podrían comprender varias especies distintas, por tanto muy posiblemente la diversidad de especies en el país sea mayor (Holst & Kawasaki 2007).

Myrcia paulii-jonesii Aguilar, D. Santam., & A. Estrada, sp. nov. (**Figs. 1, 2**). TIPO: COSTA RICA. PUNTARENAS: Cantón Osa. Península de Osa, Bahía Chal-Bajo San Juan, Finca Rafael Granados Altamirano, 08°45'20"N, 83°30'52"W, 53 m, 01 Ago 2013 (fls), *N. Zamora, R. Aguilar, S. Kim, G. Villalobos, A. Azofeifa, D. Solorzano 6494* (HOLOTIPO: CR, ISOTIPOS: F, GH, K, MO, NY, SEL, USJ).

Myrcia paulii-jonesii sp. nov. is similar to *Myrcia pentagona* McVaugh and *Myrcia antioquensis* Parra-O. It differs from *M. pentagona* by its appressed pubescence, not pannose or deciduous in groups in drying (vs. pubescence pannose and deciduous in groups in drying), its wider leaves (6.1–13.3 cm vs. 5–7.5 cm), the midvein that is slightly raised towards the distal half (vs. sulcate), a short and slightly revolute leaf base (0.5–1 cm vs. 1–5 cm from the base) and its smooth and unridged hypanthium (vs. a hypanthium with 5 prominent ridges). It differs from *M. antioquensis* by its appressed pubescence (vs. tomentose), its narrower leaves (6.1–13.3 cm vs. 7.8–16.5 cm), its smooth, unridged hypanthium (vs. a hypanthium with 5 prominent ridges), its smooth fruits (vs. fruits with 5 distinct ridges), and by its shorter inflorescences (6–17 cm vs. (8–)14–32 cm in length).

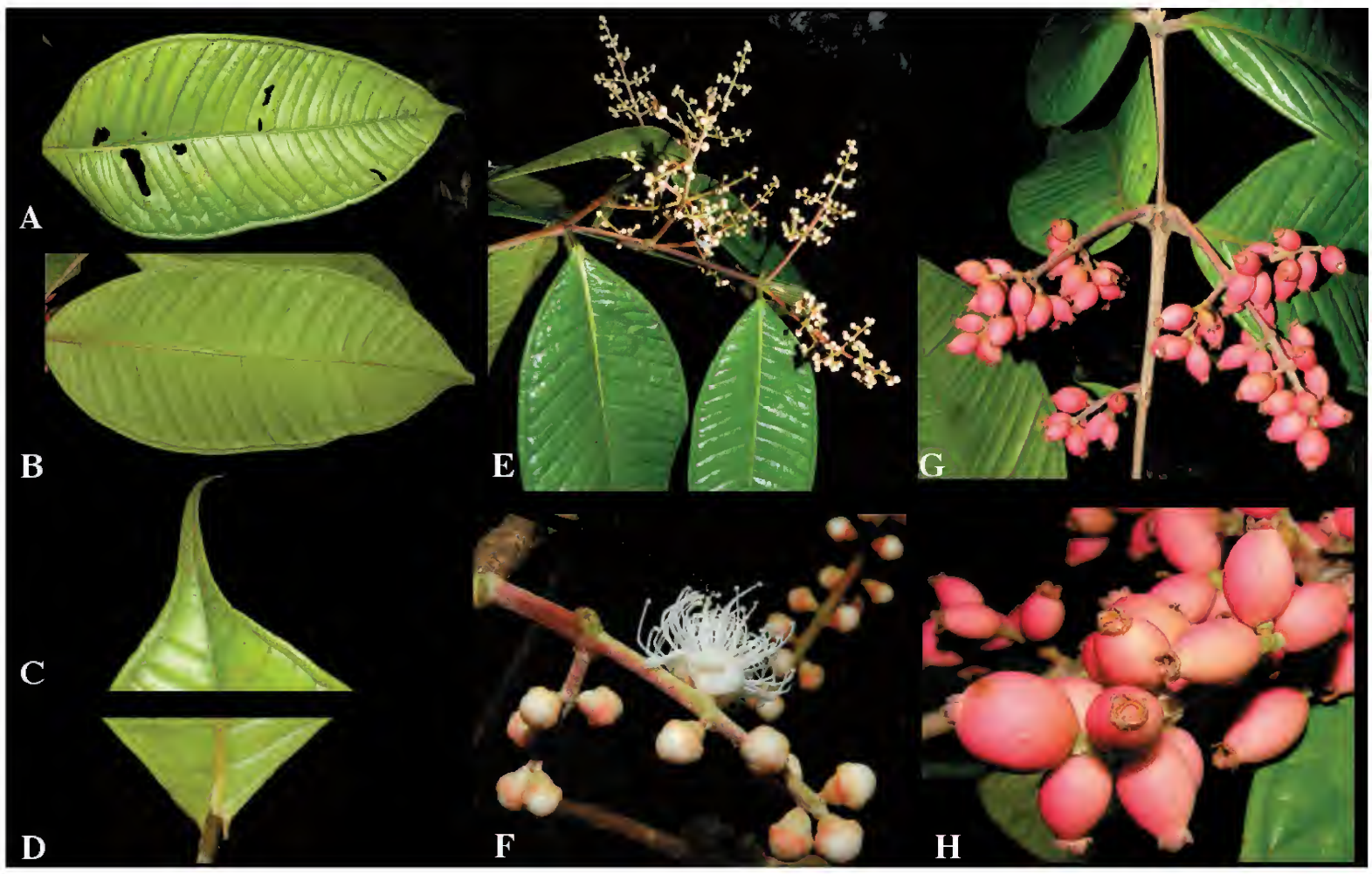


Fig. 1. A–H. *Myrcia paulii-jonesii*. **A.** Haz. **B.** Envés. **C.** ápice. **D.** Base. **E.** Rama con inflorescencias. **F.** Flor y botones florales. **G.** Rama con infrutescencias. **H.** Frutos. (A–D, G, H de *R. Aguilar 12300*; E, F de *N. Zamora et al. 6494,* holotipo). Fotos por R. Aguilar.

Arbusto o arbolito 2–10 m de alto, hasta 25 DAP; yemas y ramitas más jóvenes densamente adpreso-pubescentes, pronto y abruptamente glabrescentes (dejando una marca o línea de cambio), los tricomas ca. 0.1–0.5 mm de largo, simples, blanquecino-grisáceos a blanquecino-amarillentos, ramitas aplanadas hacia la parte distal, sulcadas, glandulosas y fistulosas. Láminas foliares (15.0–)17.6–34.5 × 6.1–13.3 cm, obovadas a más comúnmente elípticas, 2–2.8 veces más largas que anchas, secando café-rojizo a verde-oliva, el haz glabro, excepto la vena media esparcidamente adpreso pubescente a glabrescente (algunas veces los nervios laterales diminutamente pubescentes), lustroso, el envés diminuto pubescente, cubierto por tricomas blanquecinos o amarillentos, ca. 0.1–0.3 mm de largo; glándulas punctatas a veces visibles en el envés, negruzcas, indistintas en el haz; vena media en el haz sulcada o plana de la mitad hacia la base de la lámina y ligeramente elevada de la mitad hacia el ápice, en el envés prominentemente elevada; nervios laterales (13–)17–22 pares por lado, sin incluir los intermedios, marcadamente impresos en el haz, prominentes en el envés; nervio marginal ligeramente arqueado entre los laterales, impreso en el haz y elevado e igual de prominente que los laterales en el envés, 0.3–0.5 cm del margen; base cuneada, leve y cortamente decurrente y revoluta (0.5–1 cm desde la base); ápice abruptamente acuminado; pecíolos (0.3–)1.0–1.4 cm de largo, densamente adpreso pubescente a glabrescente con la edad, sulcados. Inflorescencias panículas, axilares o subterminales, 6–17 cm de largo, erectas, solitarias, ejes y ramitas irregularmente aplanadas a estrechamente 4 anguladas, densamente adpreso pubescentes, tricomas blanquecinos; brácteas y bractéolas posiblemente deciduas, no observadas; pedúnculos 2–5.5 cm de largo, 3–3.5 mm de ancho bajo el primer nodo, aplanados. Flores 5-meras; botones 4–4.5 mm de largo, sésiles o cortamente pedicelados, ca. 0.1–1 mm de largo, hipanto 2–2.5 mm, densamente adpreso-pubescentes hacia la base, tricomas blanquecino-amarillentos, liso (a veces arrugado longitudinalmente producto del secado), lobos del cáliz 1.5–2 mm × 2–2.5 mm, desiguales, imbricados, ± en forma de "D," el ápice redondeado o agudo, adpreso pubescente en ambas superficies, persistentes y extendidos en el fruto; pétalos cuando la flor en botón ca. 2.5.–4.0 × 2.9–3.6 mm, blancos, esparcidamente pubescentes en ambas superficies, el ápice redondeado;

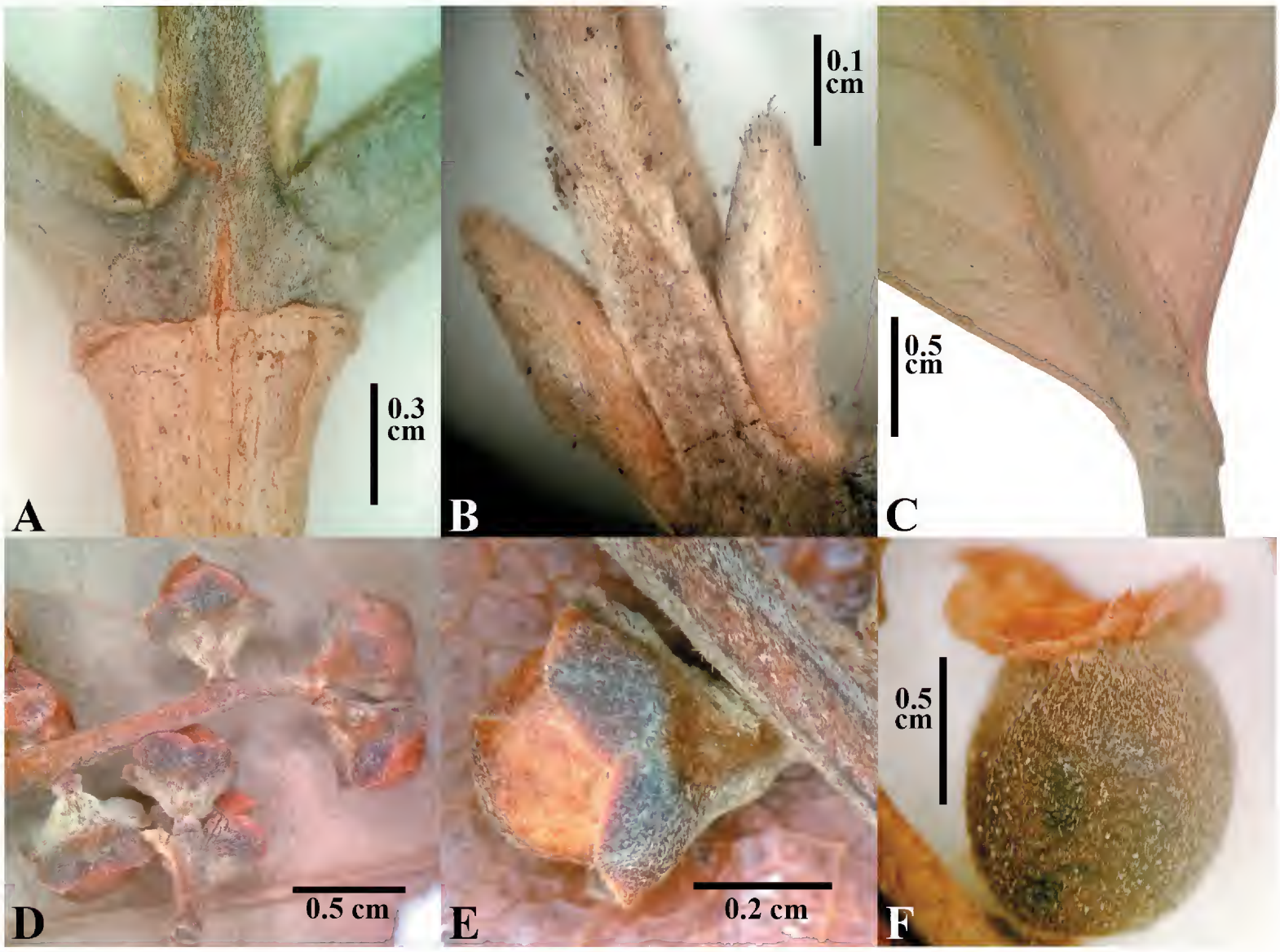


Fig. 2. A–F. *Myrcia paulii-jonesii*. A. Ramitas adpreso pubescentes y luego abruptamente glabrescentes (marca de cambio). **B.** Yemas y ramitas nuevas denso adpreso-pubescentes. **C.** Base revoluta y decurrente. **D.** Ramita de inflorescencia con botones florales. **E.** Botón floral. **F.** Frutos. (A– E de *N. Zamora 6494*; F de *R. Aguilar 3582*). Fotos por A. Estrada.

estambres + 160 por flor, filamentos 3.0–6.0 mm de largo, glabros, blancos, anteras ca. 0.2–0.5 mm, el ápice del conectivo con una glándula conspicua; estilo 4.5–6 mm de largo, pubescente en la mitad proximal, glabro distalmente. Frutos 0.8–1.2 × 0.4–0.7 cm, generalmente elipsoides, glandulosos, esparcidamente pubescentes, tricomas más abundantes hacia el ápice y los lobos del cáliz, rosados o rojo-rosados; semilla 1, 0.5–0.7 × 0.25 cm café oscuro a negruzcas, lisas a un poco rugosas.

Fenología.—Flores en julio y agosto. Frutos en agosto y septiembre.

Distribución y Hábitat.—*Myrcia paulii-jonesii* es una especie endémica de Costa Rica. Se distribuye en los bosques muy húmedos en el Pacífico Sur costarricense, en la Península de Osa (Bahía Chal y alrededores), entre 10 y 100 m de elevación (Fig. 4). Se ha recolectado en orillas de caminos y claros naturales, en terrenos con ligera pendiente. Se ha observado que localmente es abundante y crece junto a elementos florísticos restringidos a esta región del país, como: *Byttneria osaensis* (Malvaceae), *Cremastosperma* sp. nov. (Annonaceae), *Inga golfodulcensis* (Fabaceae), *Miconia osaensis* (Melastomataceae), *Schnella bahiachalensis* (Fabaceae), *Williamodendron glaucophyllum* (Lauraceae).

Discusión.—*Myrcia paulii-jonesii* es una especie llamativa, que se caracteriza por sus ramitas jóvenes aplanadas, glandulares y densamente cubiertas por tricomas adpreso-blanquecinos; láminas foliares relativamente grandes, blanquecino-grisáceas en el envés (cuando secas), con la base levemente revoluta, nervios laterales y marginal muy conspicuos, fuertemente impresos en el haz y elevados en el envés y por sus frutos elipsoides rosados, glandulosos y esparcidamente pubescentes. En estado juvenil esta especie llega a tener

láminas foliares mucho más grandes ca. 34.5–53.5 × 11.4–13 cm, con el ápice cirriforme y tricomas ± largos, blanquecinos y erectos que cubren las ramitas, hojas y pecíolos.

Esta especie es similar a *Myrcia pentagona* McVaugh (de la Amazonía peruana) y a *Myrcia antioquensis* Parra-O. (de los bosques subandinos de Colombia), con las cuales comparte las siguientes características: hojas grandes (> 14 cm), con la vena marginal y las venas laterales muy prominentes en el envés e impresas en el haz, éstas últimas numerosas (usualmente más de 20), la vena media ligeramente elevada en la mitad distal (solo compartido con *M. antioquensis*) y la base de alguna forma revoluta. Además de las inflorescencias grandes y robustas, con ejes aplanados a cuadrangulares. No obstante se diferencia de *M. pentagona* por su pubescencia adpresa, no afelpada ni caediza en grupos al secar (vs. pubescencia afelpada y caediza en grupos al secar), por sus hojas más anchas (6.1–13.3 cm vs. 5–7.5 cm), con venas terciarias más marcadas y evidentes, la vena media ligeramente elevada hacia la mitad distal (vs. sulcada), la base foliar leve y cortamente revoluta (0.5–1 cm vs. 1–5 cm desde la base) y su hipanto liso, no acostillado (vs. hipanto con 5 costillas prominentes). De *M. antioquensis* se diferencia por su pubescencia adpresa (vs. tomentosa), sus hojas más estrechas (6.1–13.3 cm vs. 7.8–16.5 cm), su hipanto liso, no acostillado (vs. hipanto con 5 costillas prominentes), sus frutos lisos (vs. frutos con 5 costillas evidentes) y sus inflorescencias más cortas (6–17 cm vs. (8–)14–32 cm de largo).

Otra especie con la que podría ser comparada por su venación prominente y la vena media elevada en el haz, es *Myrcia crassimarginata* McVaugh de Perú, pero se distingue de ésta por sus hojas más grandes (17.6–34.5 × 6.1–13.3 cm vs 16–20 × 7–8 cm), corto-pubescentes y lisas en el envés (vs. envés casi glabro y verruculoso), base cuneada (vs. base redondeada), pecíolos más largos (10–14 mm vs 3–6 mm), inflorescencias más cortas (6–17 cm vs 15–23 cm de largo) y brácteas y bractéolas deciduas antes de la antesis (vs. persistentes hasta la antesis).

Entre las especies costarricenses se parece un poco a *Myrcia* sp. A (Holst & Kawasaki 2007), del Caribe de Costa Rica y Panamá, ya que ambas comparten láminas foliares relativamente grandes y venación prominente e impresa; no obstante se diferencia de esta especie por sus pecíolos más largos (1.0–1.4 vs. 0.5–0.8 cm), hojas con la vena media elevada en la mitad distal y esparcidamente pubescente (vs. sulcada y densamente pubescente), los nervios secundarios menos numerosos (17–22 vs. 20–30) y la base foliar revoluta y decurrente (vs. base recta). Se diferencia además por sus ramitas con pubescencia adpresa y blanquecina, pronto glabrescentes (vs. tricomas patentes, amarillos a ferrugíneos, persistentes).

Etimología.—Esta especie es nombrada en honor al Sr. Paul Jones, en reconocimiento por apoyar los esfuerzos en la conservación y la investigación de uno de los lugares más abundantes en biodiversidad del planeta, la Península de Osa.

Paratipos. **COSTA RICA. Puntarenas:** Osa, Sierpe. Reserva Forestal Golfo Dulce. Península de Osa. Los Mogos. Bahía Chal. Entrada a Chocuaco, 08°46'20"N, 83°22'40"W, 100 m, 24 Ago 1994 (fr), *R. Aguilar et al 3582* (INB); Reserva Forestal Golfo Dulce. Bahía Chal, a 35 km de Chacarita, entrada a Chocuaco, entre cruce de Bajo Chocuaco y el bajo quebrada Lagunas, 08°43'45"N, 83°27'25"W, 10 m, 24 Sep 2009 (fr), *R. Aguilar 12300* (GH, MO); misma localidad que *R. Aguilar* 12300, 24 Mar 2012 (Est), *D. Santamaría & R. Aguilar 9355* (CR, GH, MO); Bajo San Juan a 1500 m al Suroeste del pueblo, río Chocuaco arriba, finca del Estado, 08°45'33"N, 83°30'45"W, 40 m, 24 Ago 2013 (bot. fls), *R. Aguilar 14572* (CR); Los Mogos, 08°43'20"N, 83°26'30"W, 20 m, 21 Jul 1993 (bot. fls), *R. Aguilar 2016* (CR, GH, MO).

Myrcia riverae A. Estrada, D. Santam., & Aguilar, sp. nov. (**Fig. 3**). Tipo: Costa Rica. Puntarenas: Cantón de Golfito. Refugio Nacional de Vida Silvestre Golfito. Terrenos estatales al E del área, camino a las torres del ICE, 08°38' 44"N, 83°09'56"W, 300 m, 03 May 2011 (bot. fls), *D. Santamaria, L. Diego Vargas, G. Villalobos 9416* (holotipo: CR; isotipos: F, GH, K, MO, NY, SEL).

This new species is distinguished within *Myrcia* by the combination of the following distinctive characters: dense velutinous, brownish-red pubescent covering almost all the plant, large leaf blades (15.5–27.2 × 7–11.6 cm), with very prominent venation on the underside of the leaf, straight leaf margins and being glandular-punctate on both leaf surfaces (though more visible on the underside), flowers with truncate calyx lobes, and oblate or globose fruits with persistent calyx lobes that are either erect or connivent.

Árbol o arbolito 8–12 m de alto, hasta 15 cm DAP; yemas y ramitas jóvenes densamente velutinas, los tricomas ca. 0.2–0.8 mm de largo, simples, erectos, café-rojizos a dorado-café, ramitas cilíndricas a ligeramente aplanadas hacia la parte distal, generalmente sulcadas y fistulosas. Láminas foliares (13.2–)15.5–27.2 × (5.5–)7–11.6 cm, obovadas o más comúnmente amplio-elípticas, 1.5–2.6 veces más largas que anchas, secando café-rojizas, el haz glabro (a veces escasa y esparcidamente pubescente), excepto en la vena media, densamente cubierta por

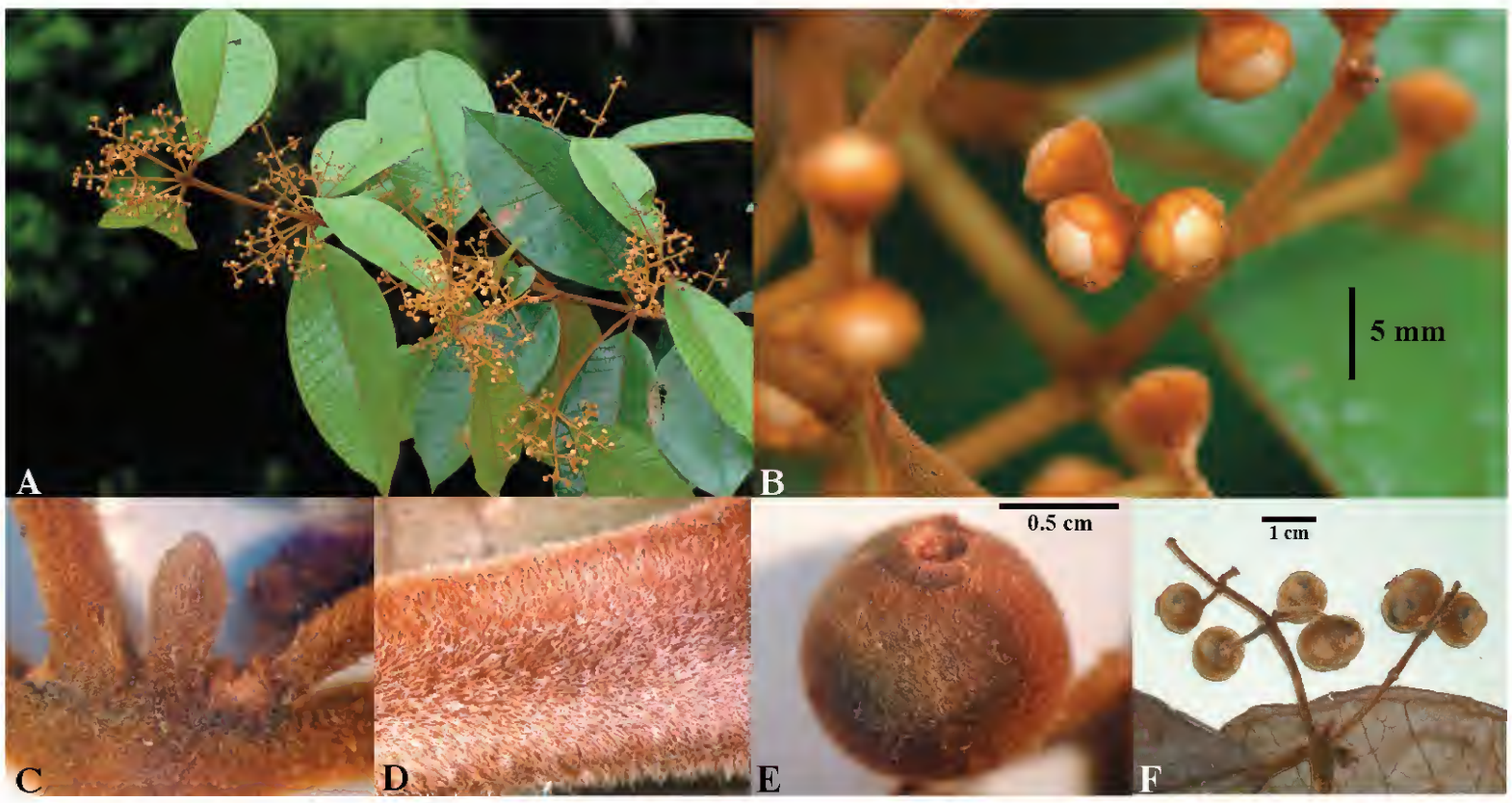


Fig. 3. A–F. *Myrcia riverae*. **A.** Rama con inflorescencias. **B.** Botones florales, mostrando los lobos del cáliz. **C.** Ramitas y yemas velutinas. **D.** Ramita velutina. **E.** Fruto con lobos del cáliz erectos. **F.** Frutos. (A, B de D. *Santamaria et al. 9416*, holotipo). Fotos por L.D. Vargas; (C de *G. Herrera 4167*, D, E y F *de G. Rivera 4557*). Fotos por A. Estrada.

tricomas simples, café-rojizos, la pubescencia disminuyendo hacia el ápice, opaco, el envés densamente pubescente, principalmente sobre los nervios, tricomas café-rojizos; glanduloso-punteadas en ambas superficies, aunque más visibles en el envés, glándulas café-rojizas a negruzcas; vena media en el haz sulcada hacia la base y plana (a veces levemente elevada) hacia el ápice, en el envés prominentemente elevada; nervios laterales 12–20 pares por lado, sin incluir los intermedios, impresos o planos en el haz, elevados en el envés; nervio marginal ligeramente arqueado entre los laterales, impreso en el haz y elevado e igual de prominente que los laterales en el envés, 0.1–0.5 cm del margen; base obtusa a cuneada, los márgenes rectos; ápice cortamente acuminado o agudo; pecíolos (0.7–)0.9–1.3(–1.6) cm de largo, densamente pubescente, ligeramente sulcado. Inflorescencias panículas, axilares o subterminales, (5.2–)6.5–13 cm de largo, erectas, de 1–3(–4) ejes por axila (decrecientes), ejes y ramas cilíndricas o aplanadas, densamente velutinas, café-rojizos a dorado-café; brácteas y bractéolas posiblemente deciduas, no observadas; pedúnculos 1.2–4.7 cm de largo, 2–2.5 mm de ancho bajo el primer nodo, aplanados. Flores 5-meras; botones 4.5–5 mm de largo, sésiles o cortamente pedicelados, 0.1–1.6 mm de largo; hipanto 3.5–4 mm, uniformente denso-velutino, tricomas café-rojizos a dorado-café, lobos del cáliz ca. 1.1 × 1.5 mm, imbricados, el ápice truncado o depreso, densamente velutinos, adaxial y abaxialmente, persistentes y erectos o conniventes en el fruto; pétalos 3.5–4 × 2.5–3 mm, blancos, seríceos en la parte adaxial, glabros abaxialmente, el ápice redondeado; estambres + 130 por flor, filamentos 3–5 mm de largo, glabros, blancos, anteras ca. 0.3–0.4 mm de largo, el ápice del conectivo con una glándula conspicua; estilo ca. 5.5–6.5 mm de largo, pubescente en la mitad proximal, glabro distalmente. Frutos 0.8–1 × 1–1.3 cm, globosos a oblatos, densamente velutinos, amarillo a anaranjados; semillas 1 ó 2, 0.7 × 0.9 cm, lisas, brillantes.

Fenología.—Flores en abril y mayo. Frutos en julio y agosto.

Distribución y Hábitat.—*Myrcia riverae* es una especie endémica de Costa Rica. Se distribuye en bosques muy húmedos en el Pacífico Sur costarricense, región de Golfo Dulce (Golfito y Península de Osa). Entre los 300 y 754 m de elevación (Fig. 4). Se ha recolectado en orillas de caminos y bordes de bosques.

Discusión.—Esta especie se puede reconocer por su densa pubescencia aterciopelada, café-rojiza, presente en ramitas jóvenes, hojas, inflorescencias y frutos; además por sus láminas foliares grandes, con venación muy prominente en el envés, glanduloso-punteadas en ambas superficies (más visibles en el envés), flores con

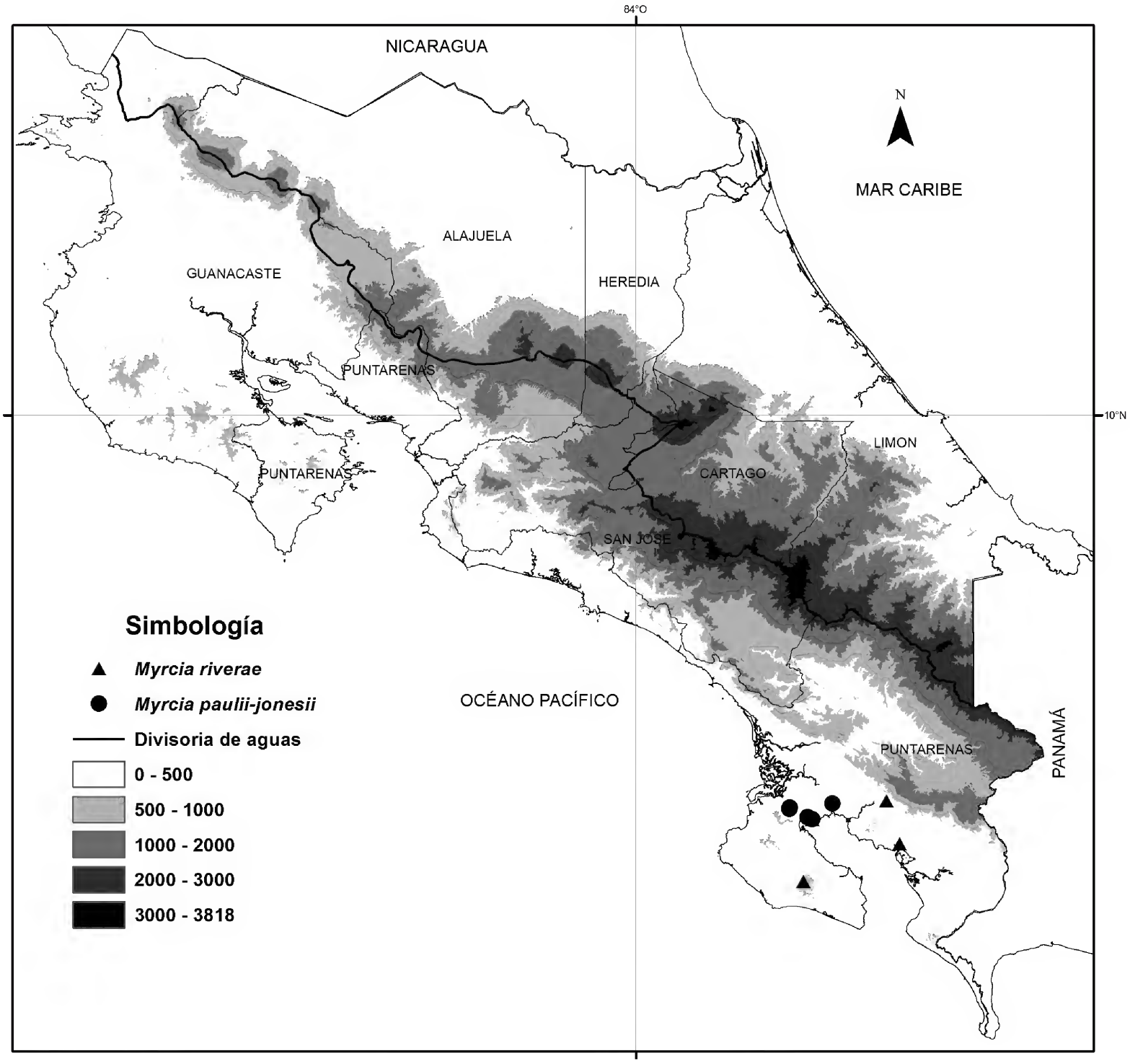


Fig. 4. Distribución de *Myrcia paulii-jonesii* sp. nov. y *Myrcia riverae* sp. nov. en Costa Rica.

los lobos del cáliz truncados y sus frutos oblatos o globosos, con los lobos del cáliz persistentes, erectos o conniventes. Estas características relacionan a *M. riverae* con el grupo *Gomidesia*, aunque muy distintiva de cualquier otra especie del grupo. En Mesoamérica *Myrcia riverae* junto a *Myrcia aliena* McVaugh, son los únicos representantes de Gomidesia en la región. Estas especies comparten la pubescencia velutina, café rojiza y en los lobos del cáliz cortos y truncados; no obstante se diferencia de *M. aliena* por sus láminas foliares más grandes (15.5–27.2 × 7–11.6 vs. 5–12.5 × 2.3–7 cm), densamente pubescentes (vs. glabrescentes), botones florales más grandes (4.5–5 vs. 2–2.5 mm) y frutos densamente velutinos (vs. glabrescentes).

Etimología.—Esta especie es nombrada en honor a Gerardo Rivera, en reconocimiento por sus incansables esfuerzos de estudio, recolecta y valoración de la flora costarricense.

Paratipos. **COSTA RICA. Puntarenas:** Cantón de Golfito. Jiménez, Dos Brazos de Río Tigre. Cerro Rincón, fila noroeste, 08°31'35"N, 83°28'12"W, 754 m, 28 Ago 1990 (fr), *G. Herrera 4167* (CR, INB, MO). Cantón de Osa. Piedras Blancas, La Florida, finca Bellavista, 08° 46,872'N-83° 12,483'W, 297 m, 30 Ago 2011 (fr), *G. Rivera & M. Nuñez 4557* (CR, MO, USJ). Reserva Forestal Golfo Dulce. Península de Osa, Bahía Chal, Los Mogos, 08°43'20"N, 83°26'30"W, 20 m, 21 Jun 1993 (bot. fls), *R. Aguilar 2016* (CR).

AGRADECIMIENTOS

Agradecemos a Chris Davidson, Sharon Christoph, de finca Playa Karé y la fundación Blue Moon por su apoyo al Proyecto de las Plantas Vasculares de la Península de Osa, Costa Rica; a Matt Hogan por las facilidades y apoyo brindado durante la investigación realizada en su propiedad Finca Buenavista, ubicada en Piedras Blancas de Osa. Además a Luis Diego Vargas por las fotografías de *Myrcia paulii-jonesii* y a Joaquín Sánchez del Hebario Nacional de Costa Rica (CR) por su colaboración en la elaboración del mapa de distribución de las especies. A Kanchi Ghandi por el asesoramiento sobre la forma correcta de escribir el epíteto de *Myrcia paulii-jonesii* y a Laura Lagomarsino por las traducciones al inglés. También agradecemos a Bruce K. Holst y a Lucia Kawasaki, por sus valiosos aportes y comentarios en la revisión del manuscrito.

Daniel Santamaría agradece a los curadores y asistentes del herbario de la Universidad de Harvard por las facilidades brindadas durante la estancia en dicho herbario; así como al Missouri Botanical Garden por el apoyo económico mediante la beca Elizabeth E. Bascom para Botánicas (os) Latinoamericanas (os), así como a todo el personal por las facilidades brindadas. También agradecemos a los siguientes herbarios por permitir el acceso a sus colecciones A, CR, F, GH, INB, LPB, MO, MOL, NY, PMA, USM.

REFERENCIAS

Holst, B.K. & M.L. Kawasaki. 2007. *Myrcia* DC. Myrtaceae. In: B.E. Hammel, M.H. Grayum, C. Herrera, & N. Zamora, eds. Manual de plantas de Costa Rica. Vol. 6. Monogr. Syst. Bot. Missouri Bot. Gard. 111:764–768.

Holst, B.K. & M.L. Kawasaki. 2009. 177. *Myrcia* DC. Myrtaceae. In: G. Davidse, M. Sousa Sánchez & A.O. Chater, eds. Fl. Mesoamer. Universidad Nacional Autónoma de México, México, D.F. 4(1):66–150.

Lucas, E., K. Matsumoto, S. Harris, E. Nic Lughadha, B. Bernardini, & M. Chase. 2011. Phylogenetics, morphology, and evolution of the large genus *Myrcia* s.l. (Myrtaceae). Int. J. Pl. Sci. 172(7):915–934.

McVaugh, R. 1968. The genera of American Myrtaceae: An interim report. Taxon 17:354–418.

McVaugh, R. 1969. Myrtaceae. In: B. Maquire & J.J. Wurdack, eds. The botany of the Guayana Highland. Part.VIII. Mem. New York Bot. Gard. 18(2):55–286.

Nic Lughadha, E., K. Slade, L. Jennings, H. Boudet-Fernandes, & E. Lucas. 2010. Three new species of *Myrcia* section *Gomidesia* (Myrtaceae)–from Espírito Santo, Brazil. Kew Bull. 65:21–28.

Parra-O., C. 2013. Una especie nueva de *Myrcia* (Myrtaceae) y nuevos registros de la familia para Colombia. Caldasia 35(2):293–298.

BOOK REVIEW

L.B. (Bert) McCarty and David W. Hall. 2011. **More Turfgrass and Related Weeds: Beyond the Color Atlas.** (ISBN-13: 978-0-9798777-5-9, pbk). Clemson University Public Service Publishing, Clemson University, Clemson, South Carolina 29634-0129, U.S.A. (**Orders:** https://shopping.clemson.edu, 1-864-656-3311). $25.00, 380 pp., color photos, glossary, index, 7" × 10".

This is a guide for identifying weeds, ostensibly for those who are weed managers. For those interested in identification of the variety of grasses, plants, and numerous flowers in the wild, it gives a clear format of indices to check.

The introduction provides a way to categorize a plant through its roots, stems, vascular systems, leaves, flowers, fruits, seeds, etc. Each page names a plant within its family, the species, and also notes its growing season and life cycle. Every plant has several close-up photos on the page which are illustrative of its habit and other specific characteristics. The page also includes shape, size, propagation, and habitat along with its distribution in the U.S. (initiating primarily from Florida) and worldwide.

I found the photos to be very helpful as they provided a clearly recognizable vehicle for identification when viewing a plant. The other details added credence when further distinguishing was needed. Within the descriptive narrative there are often extra snippets of interest such as what plants are used for medicinal purposes or for teas, if edible or poisonous, and whether drought tolerant or invasive.

Since this reading I have identified plants which have heretofore gone unrecognized, and now provide me with the knowledge to either keep or dispense with as per information gained.—*Pat Gerard, Botanical Research Institute of Texas Volunteer, Fort Worth, Texas, U.S.A.*

TAXONOMIC STUDIES IN THE MICONIEAE (MELASTOMATACEAE). XII. REVISION OF *MICONIA* SECT. *MICONIASTRUM*, WITH EMPHASIS ON THE *MICONIA BICOLOR* COMPLEX

Walter S. Judd

Department of Biology and
Florida Museum of Natural History
University of Florida
Gainesville, Florida, U.S.A.
wjudd@botany.ufl.edu

James Dan Skean, Jr.

Department of Biology
Albion College
Albion, Michigan 49224, U.S.A.
dskean@albion.edu

Eldis R. Bécquer

Jardín Botánico Nacional
Universidad de La Habana,
Carretera "El Rocío" Km 3.5, Calabazar, Boyeros, CP 19230
La Habana, CUBA
erbecquer@fbio.uh.cu, pachyanthus@gmail.com

Lucas C. Majure

Department of Biology and
Florida Museum of Natural History
University of Florida
Gainesville, Florida, U.S.A.
lmajure@ufl.edu

ABSTRACT

A new section, **Miconia** sect. **Miconiastrum,** is recognized (and includes species previously placed in *Calycogonium*, *Charianthus*, *Miconia,* and *Tetrazygia*). Within this clade, the species of the *Miconia bicolor* complex are revised. For the nine species of the *M. bicolor* complex, descriptions, nomenclatural information (including four new names: **Miconia karsticola, M. guajaibonensis, M. cajalbanensis,** and **M. maestrensis**), specimen citations, and eco-geographical characterizations are presented, along with an identification key to members of the section. *Miconia* sect. *Miconiastrum* represents a monophyletic group within the Caribbean clade of tribe Miconieae (Melastomataceae) and the group is restricted to southern Florida, the Bahamas, Cuba, and Hispaniola. The clade is characterized by hypanthia strongly constricted in fruit, more or less reduced calyx teeth, obovate to spathulate petals, stamens dropping before the petals abscise, and leaves with globular-stellate to stellate hairs or peltate scales on the abaxial surface. Most species possess mite domatia formed from a dense tuft of elongate, multicellular, barbate, eglandular hairs in the axils of the midvein and major secondary veins, and they have seeds with smooth to slightly bulging testa cells. Within sect. *Miconiastrum* a large subclade, i.e., the *M. bicolor* complex, is diagnosed by 5- or less commonly 6-merous flowers with the petals abaxially papillose-granulose. All members of this clade, except for *M. karsticola,* also possess paniculate-cymose inflorescences of numerous flowers and abaxial leaf surfaces usually densely covered with well-developed stellate hairs or peltate scales. Within the *M. bicolor* complex, indumentum characters (as observed on the abaxial leaf surface), form of the calyx tube, size of the calyx lobes, and presence/absence of mite domatia are taxonomically significant.

RESUMEN

Se reconoce una nueva sección, **Miconia** secc. **Miconiastrum** (que incluye especies previamente conocidas bajo los géneros *Calycogonium*, *Charianthus*, *Miconia*, y *Tetrazygia*), y dentro de este clado se revisa la taxonomía de los miembros del complejo *Miconia bicolor.* Para las nueve especies del complejo *M. bicolor*, presentamos descripciones, información nomenclatural (incluyendo cuatro nombres nuevos: **Miconia karsticola, M. guajaibonensis, M. cajalbanensis,** y **M. maestraensis**), citaciones de especímenes, caracterizaciones ecogeográficas y una clave de los miembros de la sección. *Miconia* sect. *Miconiastrum* representa un grupo monofilético dentro del clado caribeño de la tribu Miconieae (Melastomataceae) y el grupo es restringido al sur de la Florida, Las Bahamas, Cuba y La Española. El clado se caracteriza por los hipantos fuertemente constringidos en el fruto, los dientes del cáliz ligera o extremadamente reducidos, los pétalos de aovados a espatulados, los estambres caducos antes de la absición de los pétalos, y las hojas con pelos estrellados, globular-estrellados, o escamas estrelladas peltadas en el envés de la hoja. La mayoría de especies poseen acarodomacios formados por un mechón de pelos alargados, multicelulares, barbados y eglandulares que se presentan en las axilas de la vena primaria con las venas secundarias mayores y también tienen semillas con las células de la testa lisas y ligeramente hinchadas. Dentro de la sect. *Miconiastrum,* un subclado grande, ej. el complejo *M. bicolor*, se distingue por sus flores 5- o menos común 6-meras, con los pétalos abaxialmente papiloso-granulosos. Todos los miembros de este clado, excepto *M. karsticola*, también poseen inflorescencias paniculadas de numerosas flores y el envés de la hoja cubierto por un indumento denso de pelos estrellados, globular-estrellados o escamas peltadas bien desarrolladas. Dentro del complejo *M. bicolor* los caracteres del indumento (del envés de la hoja), la forma del tubo del cáliz, el tamaño de los lóbulos del cáliz, y la presencia o ausencia de acarodomacios tienen un significado taxonómico.

KEY WORDS: *Miconia*, *Tetrazygia*, *Miconia* sect. *Miconiastrum*, Miconieae, Melastomataceae

During the course of work on the systematics and phylogeny of Miconieae (Melastomataceae), we have become aware of a number of taxonomic problems, especially in the species of the Greater Antilles. Recent phylogenetic analyses (Bécquer et al. 2008; Goldenberg et al. 2008; Martin et al. 2008; Michelangeli et al. 2008) showed nearly all of the genera of Miconieae, including *Miconia* Ruiz & Pav., itself, to be highly polyphyletic, a result that is in keeping with the history of problematic generic delimitations within the tribe (Cogniaux 1891; Gleason 1925, 1932, 1958; MacBride 1941; Wurdack 1972, 1980; Judd 1986, 1989; Judd & Skean 1991). Alain (1957), Proctor (1972), and Wurdack and Kral (1982) also have noted the problematic separation of *Tetrazygia* from *Miconia*. As a result, major changes in generic circumscriptions are required. It is clear that nearly all currently recognized genera, many with numerous Caribbean species, e.g., *Calycogonium* DC., *Clidemia* D. Don, *Leandra* Raddi, *Miconia*, *Ossaea* DC., *Pachyanthus* A. Rich., and *Tetrazygia* Rich., are not supported. The most workable solution to this classificatory problem (as clearly evident in Figs. 1–3 of Goldenberg et al. 2008; or Fig. 1 of Michelangeli et al. 2008) is to place most species of Miconieae (including those treated in this paper) within a greatly expanded *Miconia*, comprising the DNA-supported clade within Miconieae that can be diagnosed by the synapomorphy of berry fruits (Goldenberg et al. 2013; Ionta et al. 2012; Ionta & Judd 2012; Majure & Judd 2012) and to conserve the large and megadiverse *Miconia* over the much smaller *Tococa* (Michelangeli, in prep.).

The authors are currently engaged in collaborative research with F.A. Michelangeli, F. Almeda, R. Goldenberg, and G.M. Ionta on the systematics of tribe Miconieae focusing on the systematics and phylogeny of Caribbean members of the tribe. In the course of this research we discovered, based on careful consideration of both molecular and morphological evidence, a distinctive clade that is most diverse in Cuba but also occurs on Hispaniola, Jamaica, the Bahamas, and in southern Florida. The purpose of this paper is to characterize this group of nine species, i.e., the *Miconia bicolor* complex, and to place this clade within the more inclusive clade (comprising ca. 11 species), here characterized morphologically and named *Miconia* sect. *Miconiastrum* (Bonpl. ex Naudin) Judd, Bécquer & Majure.

The monophyly of *Miconia* sect. *Miconiastrum* is supported both by morphology and DNA-sequence data (Goldenberg et al. 2008; Michelangeli et al. 2008, who included in their analyses the species *M. barbata* (Borhidi) Judd, Bécquer & Majure, *M. bicolor* (Mill.) Triana, *M. cajalbanensis* Judd, Bécquer & Majure (as *Tetrazygia coriacea* Urb.), *M. cristalensis* (Borhidi) Judd, Bécquer & Majure, *M. guajaibonensis* Judd, Bécquer & Majure (as *T. lanceolata* Urb.). Additionally, Majure et al. (2014) included the species *M. angustiflora* (Benth.) Naudin (as *T. pallens* (Spreng.) Cogn.), *M. karsticola* Judd, Bécquer, Skean & Majure (as *Calycogonium saxicola* Britton & P. Wilson), of the *M. bicolor* complex, and the basally diverging *M. fadyenii* (Hook.) Judd & Skean (as *T. fadyenii* Hook.) and showed high support for the clade (bootstrap = 96). Michelangeli et al. and Majure et al. (unpubl. data) have also included the two subsequent sister species of the clade, *Miconia delicatula* A. Rich. and *Clidemia swartzii* Griseb., and recovered the clade with high support. Putative synapomorphies of this clade include the constricted hypanthium (in fruit; Figs. 1D, 3E, 6D), more or less reduced calyx teeth (Figs. 1A, B, 3A. D. E. 6A–D), obovate/spathulate petals (Figs. 1, 3, 6), and the stamens dropping before the petals (Figs. 1B, 3A, 6A–C). The flowers range from 4- to 6-merous. Preliminary DNA-based phylogenetic analyses (Michelangeli et al., unpublished) suggest that *Miconia delicatula* (Fig. 1A) is sister to the remaining members of the clade, and the characteristic mite domatia, consisting of a tuft of elongate, multicellular, eglandular, barbate hairs in the axil of the midvein and major secondary veins, likely are synapomorphic for all members of the section (see Figs. 1C, 6A) except for *M. delicatula* (although they have been lost in a few species, e.g., *M. cristalensis* and *M. maestrensis* Judd, Bécquer & Majure; Fig. 6D). All have stellate hairs, although polarities regarding hair form are unclear. The hairs of *M. fadyenii* and *M. karsticola* are quite reduced, while those of *M. delicatula* are large and globular-stellate. Well-developed, usually dense, and more or less flattened, stellate hairs (with arms radiating mainly parallel to the epidermal surface, thus termed "stellate" following nomenclature of Wurdack 1986) or peltate scales ("lepidote" hairs in the terminology of Wurdack 1986) are characteristic of the remaining species. *Miconia fadyenii* likely was the next species to diverge (possibly along with *Clidemia swartzii*), and this putative clade is sister to the *M. bicolor* complex (Michelangeli et al., unpublished analyses).

Miconia fadyenii (Fig. 1B) is especially distinctive because of its adaptations for hummingbird pollination, and for this reason has often been placed in *Charianthus* D. Don (see for example, Proctor 1972), but the close relationship of this species to *M. bicolor* was first noted by Penneys and Judd (2003, 2005). Within sect. *Miconiastrum* the species of the *M. bicolor* complex, here studied in detail, can be diagnosed by their 5- or 6-merous flowers with papillose to granulate petals (either abaxially, or both adaxially and abaxially). This morphologically cohesive subclade is also strongly supported by molecular data (Bécquer et al. 2008; Goldenberg et al. 2008; Michelangeli et al. 2008, and unpublished analyses) and includes *M. angustiflora*, *M. barbata*, *M. bicolor*, *M. cajalbanensis*, *M. cristalensis*, *M. guajaibonensis*, *M. impressa* (Urb.) Judd, Bécquer & Majure, *M. karsticola*, and *M. maestrensis*.

As noted above, *Clidemia swartzii* may also belong in *Miconia* sect. *Miconiastrum*, but this Jamaican endemic, which has axillary, 4-merous flowers and large leaves with numerous elongate, multicellular, eglandular hairs along with minute globular-stellate hairs, has none of the putative morphological synapomorphies of this clade. Its placement in sect. *Miconiastrum*, therefore, requires confirmation through additional DNA samples, as well as analyses including additional species. We note that *M. fadyenii* also is 4-merous, and this character may be a synapomorphy of a hypothesized *C. swartzii* + *M. fadyenii* clade.

Although not included in the DNA-based analysis of Goldenberg et al. (2008) and Michelangeli et al. (2008), the rare Cuban endemic, *Miconia ancistrophora* (C. Wright) Triana, is similar to *M. delicatula* in its deciduous habit, flowers with distinctly clawed petals and stamens often forming two groups, and like *M. delicatula* it may belong in sect. *Miconiastrum*. This hypothesis is supported by several morphological characters: its constricted hypanthium, short calyx teeth, obovate petals, and subulate stamens with a small dorsal pore. We note that its flowers are 4- or 5-merous, the ovaries also 4- or 5-locular, and the seeds somewhat different from those of other species of sect. *Miconiastrum*, i.e., they are 1.3–2.7 mm long and the raphe is broad and deeply sunken (Bécquer, unpublished data). *Miconia ancistrophora* is easily distinguished from all the species here placed in sect. *Miconiastrum* by the bulla-based hairs on its adaxial leaf surfaces. However, definitive placement of this species must await molecular investigation.

Miconia bicolor, the most common and broadly distributed species in the *M. bicolor* complex, was the first to be described, as *Melastoma bicolor* Miller (1768), and this species was transferred to *Tetrazygia* by Cogniaux (1891). The Jamaican species, *M. angustiflora,* was next described, as *Diplochita angustiflora* Bentham (1846), although this taxon long has been known under the misapplied name *Melastoma pallens* Sprengel (1822; transferred to *Tetrazygia pallens* (Spreng.) Cogniaux in 1891). *Miconia maestrensis* was described next, as *Miconiastrum lambertianum* Bonpl. ex Naudin (1850), and occurs in the Sierra Maestra region, Cuba. This taxon was long misunderstood and usually has been considered within synonymy (under either *M. bicolor* or *M. angustiflora*). The Pinar del Río, Cuba, endemic, *Miconia karsticola* was described by Britton and Wilson (1920, as *Calycogonium saxicola*) and placed in *Calycogonium* (instead of *Tetrazygia*) because of its reduced inflorescences and small leaves, which convergently suggested a relationship with species such as *C. glabratum* (Sw.) DC., i.e., the glabrate-domatial clade (Judd & Skean 1991) within *Calycogonium*. The glabrate-domatial clade, however, has 4-merous flowers and differently formed domatia, i.e., the hairs are usually non-barbate and connate. Then, in a major paper, Urban (1926) described the narrowly endemic Cuban species *M. guajaibonensis* (as *Tetrazygia lanceolata*), *M. impressa* (in which we include *T. versicolor* Urb. and *T. minor* Urb., also described in the same publication) and *M. cajalbanensis* (as *T. coriacea*). Lastly, Borhidi (1977) described the eastern Cuban endemics *M. cristalensis* (as *T. cristalensis* Borhidi) and *M. barbata* (as *T. barbata* Borhidi).

This brief account clearly demonstrates that these species usually have been treated within *Tetrazygia*; they are considered within this genus in all Antillean or Florida floras (Small 1913; Urban 1920–21; Barker & Dardeau 1930; Moscoso 1943; West & Arnold 1956; Alain 1957; Proctor 1972; Long & Lakela 1978; Correll & Correll 1982; Liogier 2000; Nelson 2011; Wunderlin & Hansen 2011; Michelangeli & Bécquer 2012) except for the phenetically divergent, *M. karsticola*, which has been placed in *Calycogonium* (Alain 1957; Michelangeli & Bécquer 2012). Not only have these species been placed in *Tetrazygia*, many have been confused with the widespread and variable *T. bicolor* (as evidenced by frequently misidentified specimens) and considered to be closely related (Cogniaux 1891; Urban 1926; Proctor 1972).

Within the *M. bicolor* complex, *Miconia karsticola* (Fig. 1C) is probably sister to the remaining species (Michelangeli et al., unpublished analyses). It differs from them in having very reduced inflorescences, smaller leaves, a shorter habit, the much smaller stellate hairs on the abaxial leaf surface, and flowers with a shorter hypanthium and more conspicuous calyx teeth (see key). The remaining species are hypothesized to form a clade, with the putative morphological synapomorphy of leaves with a dense indumentum of stellate hairs (or peltate scales). Among these species, those with an abaxial leaf indumentum of stellate hairs, e.g., *M. angustiflora*, *M. barbata*, *M. cristalensis*, and *M. maestrensis* (Fig. 6A, B, D), are likely early divergent, while *M. bicolor* and *M. guajaibonensis* (Figs. 1D, 3A–D) are presumably derived (and closely related) as suggested by their indumentum of stellate-peltate scales. The scales of these two species may have evolved from stellate hairs through the fusion of the individually radiating arms of the hairs.

Miconia sect. *Miconiastrum* and the *M. bicolor* complex are restricted to the Caribbean region, occurring only on Cuba, Jamaica, Hispaniola, the Bahamas, and in southern Florida. *Miconia* sect. *Miconiastrum* is most diverse in Cuba, which has nine species, eight of these in the *M. bicolor* complex, and all endemic except for *M. bicolor*, itself, which is widespread (occurring on Cuba, Hispaniola, the Bahamas, and in southern Florida; Fig. 4). Jamaica is next with two species, i.e., *M. angustiflora* of the *M. bicolor* complex, and the early divergent *M. fadyenii*, both endemic to the island. Hispaniola, southern Florida, and the Bahamas each contain only a single species, the widespread *M. bicolor*. It is of interest that *M. bicolor* does not occur in Jamaica, which instead has the phenetically similar *M. angustiflora* that has sometimes been considered conspecific. *Miconia bicolor* also is not common in the "Oriente" region of Cuba, where *M. cristalensis, M. barbata*, and *M. maestrensis,* all of which also have been confused with *M. bicolor*, are restricted. However, a few problematic collections (including the type of *Tetrazygia acunae* Borhidi) from the provinces of Guantánamo, Holguín and Santiago de Cuba are tentatively placed within this species (see discussion under *M. bicolor*). The region of highest species diversity is the Prov. of Pinar del Río, Cuba, in which five species of the *M. bicolor* complex occur: *M. bicolor, M. cajalbanensis, M. guajaibonensis, M. impressa*, and *M. karsticola* (Figs. 2, 4, 5). All of these, except for *M. bicolor*, are endemic to the province. We note that *M. cajalbanensis, M. guajaibonensis*, and *M. karsticola* occur in areas of high endemism (Fig. 5): Pan de Guajaibón, the Cajálbana region, and the Sumidero region, respectively (Borhidi & Muñiz 1986; Borhidi 1991). For information on the vegetation and floristics of the plant communities in which these species occur the reader should consult Alain (1946), Berazaín (1987), Borhidi (1991), Carabia (1945), Borhidi & Muñiz (1986), Seifriz (1943), Smith (1954), and Vásquez et al. (2006) for Cuba; Ciferri (1936), García and Mejía (2008), Hager & Zanoni (1993), Lorenzo et al. (1997), Mejía et al. (2011), and Zanoni et al. (1990) for Hispaniola; Coker (1905), Correll and Correll (1982), Smith et al. (1992), and Nickrent et al. (2008) for the Bahamas; and Alexander (1967), Myers and Ewel (1990), Olmsted et al. (1983), and Phillips (1940) for Florida.

As stated previously, molecular analyses (Majure et al., unpublished data; Michelangeli et al., unpublished data) support the hypothesis that *Miconia delicatula*, an endemic to Pinar del Río, Cuba, is sister to the remaining species of sect. *Miconiastrum*. *Miconia karsticola*, another Pinar del Río endemic, is sister to the remaining species of the *Miconia bicolor* complex. These patterns suggest that sect. *Miconiastrum* originated in western Cuba, where it is still most diverse, and dispersed twice to Jamaica: an early dispersal event leading to *M. fadyenii* (and possibly also *Clidemia swartzii,* if this species actually belongs in the clade) and a later event resulting in *M. angustiflora*, along with other dispersal events to central or eastern Cuba. Some of these dispersal events may have occurred earlier and resulted in *M. cristalensis, M. barbata* and probably also *M. maestrensis*, all of the "Oriente" region, and some later, involving *M. bicolor*, which occurs in central Cuba, (especially in Prov. Villa Clara and Sancti Spíritus), and sparingly also in the "Oriente" region (Prov. Guantánamo, Holguín, Santiago de Cuba). Of course, *M. bicolor* also has dispersed to Hispaniola, where the plants are distinctive in having consistently erect, dendritic to globular-stellate hairs or scales on the stems, and also southern Florida and the Bahamas, where the plants have stems covered with more or less appressed stellate-peltate scales.

Chromosome counts are known from only two species, *M. bicolor* and *M. angustiflora*, and these have $n = 17$, which is the most common number in the tribe (Solt & Wurdack 1980).

MEASUREMENTS, TERMINOLOGY, METHODS, AND SPECIES CONCEPTS

Nearly 700 specimens of the *Miconia bicolor* complex (of sect. *Miconiastrum*) were examined for this study. The second author has collected *M. barbata, M. bicolor, M. cajalbanensis, M. cristalensis, M. guajaibonensis, M. karsticola,* and *M. maestraensis,* while the first and third authors have collected *M. bicolor* and *M. angustiflora* (see specimens examined). Herbaria from which specimens were studied are listed in the Acknowledgments. Abbreviations follow Thiers (2012). Acronyms and citation of collection numbers for Cuban specimens follows Regalado et al. (2010). One hundred and forty-three different characters were measured or observed for each species.

All measurements included in the key and descriptions of species were taken directly from dried material, with the exception of plant height and flower/fruit color, which were taken from information on specimen labels, observed in the field, or in photographs, and floral measurements, which were taken from rehydrated material. Colors of floral structures, placement of petals and stamens, and calyx tube length were all assessed at anthesis. Terminology and measurement of floral parts follow Judd (2007), Judd & Ionta (2013), and Judd et al. (2014).

Species delimitations were based on the morphological-phenetic species concept (Judd 2007) and the diagnostic species concept (Wheeler & Platnick 2000). Finally, the lead researchers in our Planetary Biodiversity Inventory, N.S.F. grant, i.e., Fabian Michelangeli, Frank Almeda, Renato Goldenberg, and Walter Judd, have agreed that it is most appropriate, at this time, to treat these species within an expanded *Miconia*.

TAXONOMIC TREATMENT

Miconia sect. **Miconiastrum** (Bonpl. ex Naudin) Judd, Bécquer, & Majure, comb. nov. *Miconiastrum* Bonpl. ex Naudin, Ann. Sci. Nat., Bot. ser. 3, 15:341. 1850. *Tetrazygia* sect. *Miconiastrum* (Bonpl. ex Naudin) Cogn., in A. de Candolle & C. de Candolle, Monogr. Phan. 7:724. 1891. TYPE: *Miconia maestrensis* Judd, Bécquer, & Majure, basionym *Miconiastrum lambertianum* Bonpl. ex Naudin.

Naudinia A. Rich. in R. de la Sagra, Hist. Phys. Cuba, Pl. Vasc. 10:266. 1846. LECTOTYPE, HERE DESIGNATED: *Naudinia chrysophylla* A. Rich. (= *Miconia bicolor* (Mill.) Triana).

Evergreen or deciduous shrubs; young stems ± rectangular to terete in cross section, lacking longitudinal ridges, the indumentum of moderate to dense, ± ferrugineous, dendritic to globular-stellate or stellate hairs, these sometimes very reduced (in *M. fadyenii* and *M. karsticola*), or peltate scales, and rarely also with elongate, eglandular, multicellular hairs (in *M. bicolor* var. *patenti-setulosa*). Leaves ± isophyllous, the blade ovate to obovate or oblong, coriaceous to chartaceous, the apex attenuate to obtuse, the base attenuate, cuneate, or acute to rounded or cordate, the margin entire to undulate; secondary veins 2 pairs, basal, the tertiary veins percurrent, oriented subperpendicular to midvein, connected by quaternary veins, or separated by composite intertertiary veins, the midvein, major secondary veins flat to moderately impressed, tertiary veins flat to slightly impressed on adaxial surface; the midvein strongly raised, the major secondary veins moderately to slightly raised, tertiary and higher order veins slightly raised to flat on abaxial surface; adaxial surface with scattered to abundant druse crystals just below surface, the indumentum initially of globular-stellate or stellate hairs, or stellate-peltate scales, but usually quickly glabrescent; abaxial surface moderately to densely covered with ferrugineous to white, or pink, globular-stellate or stellate hairs, these sometimes minute, or with moderate to dense, ± ferrugineous stellate-peltate scales; mite domatia consisting of a tuft of elongate, ± barbate, eglandular, multicellular hairs in the junction of midvein and major secondary veins (and occasionally in other vein axils) in most species (but entirely absent in *M. cajalbanensis, M. cristalensis, M. delicatula*, and *M. maestrensis*). Inflorescences terminal (but also axillary in *M. delicatula*), paniculate cymes of numerous flowers (but reduced to a solitary flower or a 3-flowered cyme in *M. karsticola*), with shoots producing several nodes before becoming reproductive. Flowers 5- or 6-merous (but 4-merous in *M. fadyenii*). Hypanthium terete, constricted above the ovary (at least in fruit), the free portion ± flaring, the outer surface with scattered, globular-stellate or stellate hairs, or peltate scales, an androecial fringe absent. Calyx lobes valvate or open (except in *M. guajaibonensis*,

where imbricate), separate in bud (but ± fused as a calyptra in *M. impressa*), the tube short, sometimes tearing between the calyx lobes, which are triangular to nearly obsolete; calyx teeth short to obsolete, usually shorter than the calyx lobes (but longer in *M. karsticola*), ± terete. Petals ± obovate, slightly to clearly asymmetric, usually spreading (but often ± erect in *M. fadyenii*), white (but red in *M. fadyenii*) at anthesis, the apex rounded, sometimes slightly asymmetrically notched, the base slightly narrowed to a broad attachment (abruptly narrowed or clawed in *M. delicatula*), the adaxial and abaxial surfaces smooth to granulate, the margin entire. Androecium zygomorphic due to stamens positioned all on one side of flower (most species), in two groups (often in *M. delicatula*), or actinomorphic (in *M. fadyenii*); stamens twice the number of petals, dropping before the petals, isomorphic, geniculate; staminal filament glabrous, but often papillose, anther thecae subulate, straight to curved, opening by a small dorso-terminal pore, at anthesis yellow, without a dorso-basal appendage, the connective not basally projecting (except in *M. fadyenii*). Ovary 3-locular (but 2-locular in *M. fadyenii*), 2/3–4/5-inferior, with conical to cylindric-conical apex, with a short, slightly ridged collar, but lacking crown, with axile placentation, the ovules numerous, borne on slightly to strongly expanded placenta, style curved distally, stigma punctate to truncate, minutely papillose. Berries globose to ellipsoid, purple-black at maturity. Seeds angular-obovoid, with smooth, ± rectangular, non-bulging raphe (but broad and deeply sunken in *M. delicatula*), the testa smooth to minutely roughened due to bulging cells; appendage absent.

At this time we can confidently recognize eleven species in this section (although a few specimens from the "Oriente" region of Cuba are only tentatively placed, and more field work may result in the recognition of additional species). All eleven species are included in the following key. However, only the species of the *Miconia bicolor* complex are revised here, and these nine species are numbered in the key. A detailed taxonomic treatment of *Miconia fadyenii* (including description, nomenclature, and specimen citations) has been presented by Penneys and Judd (2003; see also Fig. 1B here). A description (and photograph) of *M. delicatula* can be found in Alain (1957; see also Fig. 1A here).

KEY TO THE SPECIES OF THE *MICONIA BICOLOR* COMPLEX AND THE RELATED *M. FADYENII* AND *M. DELICATULA*

1. Inflorescences terminal and axillary; plants deciduous, blooming when leaves of the previous season have abscised and new leaves are just flushing out _____ **Miconia delicatula**
1. Inflorescences exclusively terminal; plants evergreen.
   2. Petals 4, bright red, abaxially smooth, erect to slightly spreading; stamens 8; ovary 2-locular, with placentas deeply intruded _____ **Miconia fadyenii**
   2. Petals 5 or 6, white, abaxially ± granulate, spreading; stamens 10 or 12; ovary 3-locular, with placentas shallowly intruded _____ **Miconia bicolor complex** [species 1–9]
      3. Leaves 0.8–3.7 cm long; stellate hairs on abaxial leaf surface minute-globular, the hairs 0.02–0.08 mm across; inflorescences of 1–3 flowers; low shrub to 1 m; hypanthium 2.8–3.5 mm long; calyx teeth usually ± conspicuous, 0.6–3 mm long _____ **1. Miconia karsticola**
      3. Leaves usually longer than 3 cm; hairs on abaxial leaf surface peltate scales or obviously stellate, the hairs 0.07–0.28 across; inflorescences paniculate cymes of numerous flowers; shrub to tree, to 1.5–10 m tall; hypanthium 4.5–8 mm long; calyx teeth usually inconspicuous, 0.1–0.5(–1) mm long.
         4. Hairs on abaxial leaf surface stellate-peltate, i.e., the arms ± connate (nearly completely to predominantly so) and forming a peltate head.
            5. Calyx lobes imbricate in young bud, unequal, i.e., the 2 outer lobes larger than the rest, and lobes always developed; calyx tube irregularly tearing between lobes; leaves small, the lamina usually less than 8.5 cm long; petals 4.5–6.3 mm long; Pinar del Río, at Pan de Guajaibón _____ **3. Miconia guajaibonensis**
            5. Calyx lobes valvate or open in young bud, equal, i.e., all ± the same size, and usually inconspicuous or nearly obsolete; calyx tube not tearing between lobes (rarely with a few irregular tears); leaves larger, the lamina usually more than 8 cm long; petals 5–11.5 mm long; plants of Cuba, U.S.A. (Florida), the Bahamas, and Hispaniola _____ **2. Miconia bicolor**
         4. Hairs on abaxial leaf surface stellate, i.e., the arms not connate or only slightly so, with longer arms proximally and short to extremely short ones distally.
            6. Leaf domatia present (and formed by elongate, barbed, multicellular, eglandular hairs) at junction of the 2 major secondary veins and the midvein.
               7. Flower buds with a nearly closed, conical calyptra and the petals thus hidden; calyx tube always regularly to irregularly tearing between the lobes; calyx lobes 0.15–0.5 mm wide (but appearing broader due to tearing of the tube); hairs of abaxial leaf surface white to very pale ferrugineous; plants of Pinar del Río _____ **4. Miconia impressa**

7. Flower buds apically open and the petals exposed; calyx tube usually not tearing at maturity, but occasionally with a few tears between lobes; calyx lobes 1.5–3.5 mm wide; hairs of abaxial leaf surface ± ferrugineous; plants of Jamaica or the Oriente region, Cuba.
   8. Domatia usually well developed, conspicuous, with elongate hairs densely distributed along 1–11 mm of midvein distal to point where joined by major secondary veins (and sometimes also at junctions with primary and tertiary veins), and all plants with domatia; plants of the central and northern "Oriente" region, i.e., Sierra de Nipe, mountains near Bayate, Monte Verde, and the vicinity of Moa and Baracoa, Cuba _____ **5. Miconia barbata**
   8. Domatia not well developed, usually inconspicuous, with elongate, ± sparse hairs and distributed along 0.25–3(–4) mm of midvein distal to point where joined by major secondary veins, and some plants entirely without domatia; plants of Jamaica _____ **6. Miconia angustiflora**

6. Leaf domatia absent.
   9. Flower buds with a nearly closed, conical calyptra and the petals thus hidden; calyx tube always regularly to irregularly tearing between the lobes; calyx lobes 0.15–0.5 mm wide (but appearing broader due to tearing of the tube); anthers 4.5–5 mm long; hairs of abaxial leaf surface ± white; plants of Pinar del Río _____ **4. Miconia impressa**
   9. Flower buds apically open and the petals exposed; calyx tube usually not tearing at maturity; calyx lobes 1–4 mm wide; anthers 4.8–8.3 mm long; hairs of abaxial leaf surface variously ferrugineous; plants of Jamaica, Pinar del Río, or the "Oriente" region of Cuba.
      10. Abaxial epidermis of lamina distinctly bullate due to the bulging of individual epidermal cells; testa roughened, with bulging cells; calyx tube 2–3.3 mm long; plants of Pinar del Río _____ **7. Miconia cajalbanensis**
      10. Abaxial epidermis of lamina ± smooth; testa smooth to roughened, the cells flat or ± bulging; calyx tube 0.8–2 mm long; plants of Jamaica or the "Oriente" region of Cuba.
         11. Hairs of abaxial leaf surface with arms predominantly radiating outward, parallel with the lamina surface, the hairs sparse to dense, and epidermis often visible; plants of Jamaica _____ **6. Miconia angustiflora**
         11. Hairs of abaxial leaf surface with arms pointing upward to radiating outward, the hairs ± dense, so epidermis obscured; plants of the Sierra de Cristal and Sierra Maestra, Cuba.
            12. Calyx lobes 1.7–3.5 mm long; leaves with tertiary veins raised abaxially; plants of the Sierra de Cristal _____ **8. Miconia cristalensis**
            12. Calyx lobes 0.3–0.6 mm long; leaves with tertiary veins flat to slightly raised abaxially; plants of the Sierra Maestra _____ **9. Miconia maestrensis**

1. Miconia karsticola Judd, Bécquer, Skean, & Majure, nom. nov. (**Fig. 1C**). *Calycogonium saxicola* Britton & P. Wilson, Mem. Torrey Bot. Club 16:91. 1920, non *M. saxicola* Brandegee, Zoe 5:215. 1905. TYPE: CUBA, Prov. Pinar del Río: S of Sumidero, Sierra Caliente, 15, 18 Aug 1915, fl, *J.A. Shafer 13770* (HOLOTYPE: NY!; ISOTYPES: A on-line image #00072013!, CAS on-line image #0002427!, NY!, US!).

Evergreen **shrub** up to 1 m. Young **stems** terete to slightly quadrangular, the indumentum of moderate, ferrugineous, globular-stellate hairs, without elongate, multicellular, non-glandular hairs, internodes 0.5–3 cm long, lacking longitudinal ridges, nodal line absent. **Leaves** isophyllous or nearly so; petiole 0.3–2 cm long, the indumentum of moderate, minute, ferrugineous, globular-stellate hairs; the blade 0.8–3.7 × 0.35–2 cm, ovate to elliptic or obovate, thinly coriaceous, the apex acute to obtuse or shortly acuminate, the base cuneate or obtuse to rounded, the margin plane, entire; secondary veins a single pair, conspicuous to inconspicuous, acrodromous, ± basal, the pair joining midvein at base to 1.5 mm above the leaf base, the secondary veins placed 0.5–3.5 mm in from margin, tertiary veins percurrent, oriented subperpendicular to midvein, 1–4.5 mm apart, obscure, the higher order veins also obscure, the midvein and secondary veins slightly impressed to flat, tertiary and higher order veins flat on adaxial surface; the midvein slightly to moderately raised, the secondary veins slightly raised to flat, the tertiary and higher order veins flat on abaxial surface; adaxial surface appearing slightly wrinkled after drying, with scattered druse crystals, and drying only slightly darker than the abaxial surface, the indumentum initially of scattered, ferrugineous, minute, globular-stellate hairs, but very quickly glabrescent; abaxial surface pale green, the surface smooth, with moderately scattered, ferrugineous, globular-stellate hairs, 0.02–0.08 mm across (appearing under low magnification as punctations), the veins with similar hairs, such hairs on lamina and veins persistent; mite domatia in axils of midvein and secondary veins, consisting of elongate, eglandular, smooth to slightly barbate, ± ferrugineous hairs, 0.1–0.5 mm long (often associated with a distinct depression in the leaf surface). **Inflorescences** terminal, a 1–3-flowered cyme, 1.3–3 cm long, 0.8–2 cm across, with no major branch pairs, the peduncle 0.4–1.7 cm long, the ultimate axes (pseudopedicels) 1.5–6 mm long, and flowers (when more than one present) well separated from each other; bracts 1.5–1.8 × 0.15–0.2 mm, narrowly triangular, with acute apex, deciduous; bracteoles 0.4–1 × 0.1–0.15 mm, narrowly

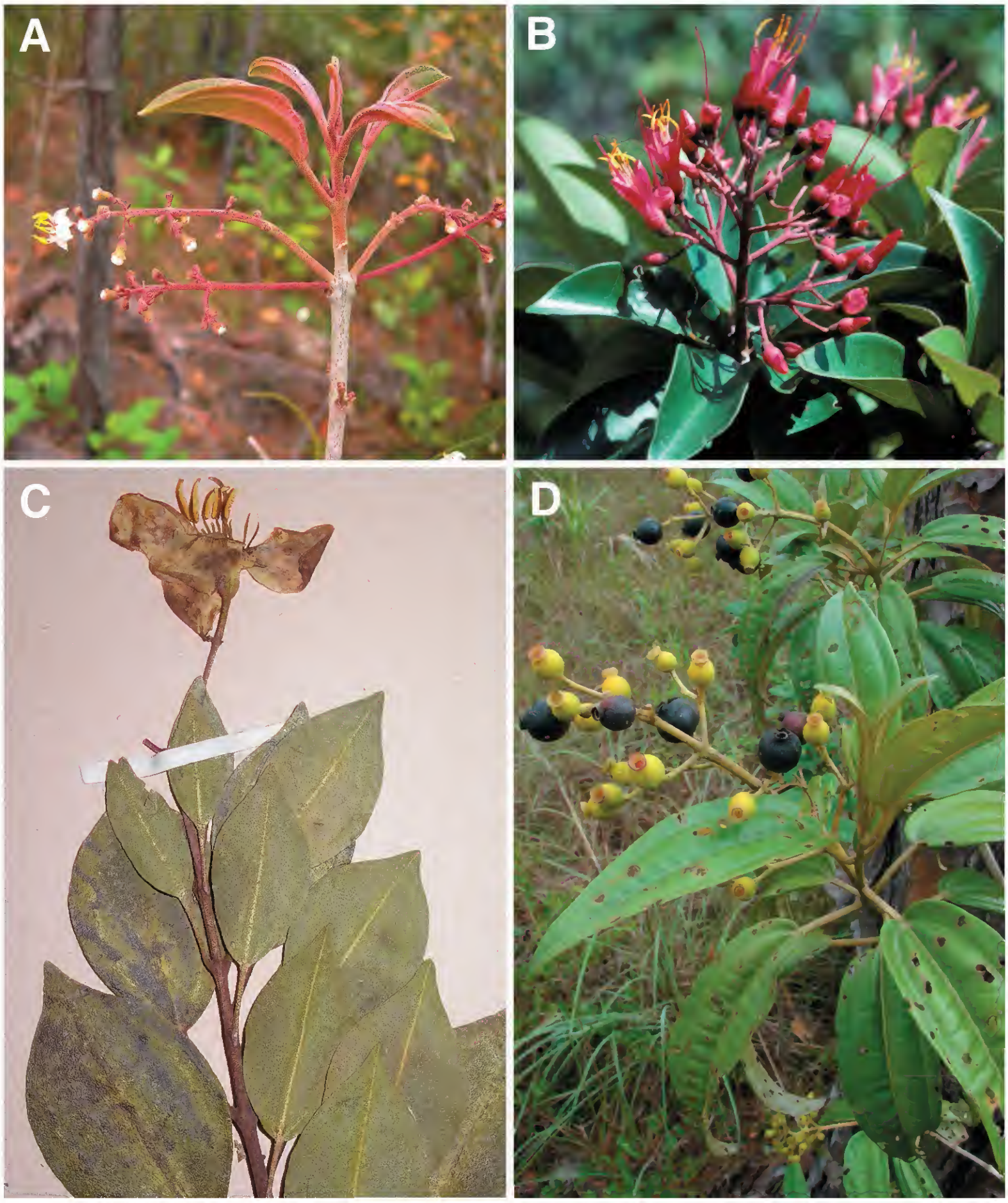


Fig. 1. **A.** *Miconia delicatula* (*Bécquer & Abbott 82421*). **B.** *M. fadyenii* (*Judd 5300*). **C.** *M. karsticola* (*Ekman 18182*). **D.** *M. bicolor* (fruiting plant, from Long Pine Key, Everglades National Park, Miami-Dade Co., Florida).

triangular, with acute apex, ± deciduous. **Flowers** 5-merous, zygomorphic (due to positioning of the stamens), with pedicel 1.4–4 mm long. **Hypanthium** 2.8–3.5 mm long, terete and slightly flaring, not constricted above ovary, the free portion 1.5–1.7 mm long, 2.5–3 mm wide at the torus, the outer surface with sparse to moderate, minute, globular-stellate hairs, the internal surface ± smooth, glabrous. **Calyx** lobes 5, separate in bud, the tube 1–1.5 mm long, not or sometimes slightly tearing between lobes, with sparse minute, globular-stellate hairs

abaxially, and glabrous adaxially, the lobes 0.2–0.4 × 1.5–3 mm, broadly triangular to nearly obsolete, the apex obtuse to rounded, with hairs similar to those of the tube but more sparsely distributed, green to red-tinged; calyx teeth present, 0.6–3 mm long, ± triangular to conic-terete, green to red, with acute apex, and hairs similar to those of calyx. **Petals** 5, 7–10 × 5–6.5 mm, asymmetrically obovate, spreading, white, glabrous but abaxial surface densely papillose-granulate, the apex rounded, sometimes slightly notched, the base slightly narrowed to a broad attachment, the margin entire. **Stamens** 10, isomorphic, ± geniculate near filament apex; staminal filament 4.7–5.3 mm long, glabrous, pale yellow, anther thecae 4.3–4.7 × ca. 1 mm, subulate, straight to slightly incurved, opening by a small dorso-apical pore, yellow, the connective not prolonged below the thecae, glabrous, but the filament emerging from slight depression in sterile, minutely dorso-lobed anther base. **Ovary** 3-locular, 1/2–2/3 inferior, globose to shortly ovoid, 2.5–3 mm long, 1.4–2.5 mm in diameter, apically conical to cylindric-conical, glabrous, the apex with small, ridged collar but lacking crown, with axile placentation, the ovules numerous, borne on small placenta; style 7–9.5 mm long, distally curved, white, glabrous; stigma punctate, minutely papillose, 0.1–0.2 mm wide. **Berries** 4–9 mm long, 4.5–9 mm in diameter, subglobose, purple-black, with scattered, minute, globular-stellate hairs, the hypanthium constricted, 2.5–3.3 mm wide at narrowest point and 2.5–3.7 mm wide at torus. **Seeds** 1–1.6 mm long, angular-obovoid, with ± rectangular raphe, the testa ± smooth; appendage absent.

Phenology.—This poorly collected species is only known in flower from May, August and November.

Distribution and habitat.—*Miconia karsticola* is endemic to the vicinity of Sumidero in Pinar del Río, Cuba (Fig. 2), occurring in rocky areas and cliffs, at ca. 70 m, on limestone.

Additional specimens examined: **CUBA. Prov. Pinar del Río:** Minas de Matahambre, Sumidero, Cueva del Resolladero en el valle de Pica Pica, 19 May 1984, *Álvarez et al. HFC-54676* (HAJB); Minas de Matahambre, Salón de los Gigantes, cerca del resollarero del río Sumidero, 70 m, 4 Apr 2008, *Bécquer et al. HFC-85175* (HAJB); Minas de Matahambre, Sumidero, Valle de Pica Pica, alrededores de Cueva Clara, 18 Nov 1978, *Bisse et al. HFC-38804* (HAJB); Sumidero, in Sierra Caliente, 24 Nov 1923, *Ekman 18182* (S, US); Loma Arenales, S of Sumidero, 20 Aug 1912, *Shafer 13797* (US); Paredón calizo de sombra, a la entrada de la Cueva de los Gigantes, Sumidero, 18 May 1991, *Urquiola et al. HPR-7569* (HAJB).

Miconia karsticola is easily distinguished from the other members of *M. bicolor* complex (within *Miconia* sect. *Miconiastrum*) by the characters presented in the key. It is especially distinctive because of its reduced inflorescences, flowers with short hypanthia, and small leaves, and these characters led to its being treated within the variable and polyphyletic genus *Calycogonium*. However, its constricted hypanthium/calyx in fruit, the leaves with mite domatia formed by clustered elongate, multicellular, eglandular, at least sometimes barbate hairs in the axils of the midvein and major secondary veins, five-merous flowers with 3-loculate gynoecia, abaxially granulose petals and seed features argue for a relationship with *Miconia bicolor* and its close relatives (in sect. *Miconiastrum*). A phylogenetic relationship with *M. bicolor* and relatives also is supported by DNA sequence data (Michelangeli et al., unpublished data).

The new name, *M. karsticola*, is required because the epithet "saxicola" is already occupied in *Miconia* (i.e., *M. saxicola* Brandegee, a Mexican species). The epithet "karsticola" refers to the floristically diverse, karstic habitat of this species and also echoes the original specific epithet. The flora in the vicinity of Sumidero, in the Sierra de los Organos, is an important center of speciation, possessing ten local endemics (Borhidi & Muñiz 1986; Borhidi 1991). This species is considered vulnerable (VU) by Borhidi and Muñiz (1983) and included in this category in the Red List of Cuban Flora (Berazaín et al. 2005) due to its limited geographical range.

2. Miconia bicolor (Mill.) Triana, Trans. Linn. Soc. London 28:103. 1872.

Evergreen **shrub or tree** to 10 m. Young **stems** terete to slightly quadrangular, the indumentum of moderate to dense, ± ferrugineous, peltate scales, or globular-stellate to dendritic hairs, these persistent to ± deciduous and stems then glabrescent, with or without elongate, multicellular, non-glandular hairs, internodes 0.8–8.5 cm long, lacking longitudinal ridges, nodal line present, faint to well-developed transverse ridge. **Leaves** isophyllous or nearly so; petiole 1.2–4.7 cm long, the indumentum of dense, peltate scales, but sometimes glabrescent; the blade 5–21.2 × 1.4–6.6 cm, ovate to elliptic or oblong, coriaceous to thinly coriaceous, the apex acuminate to attenuate, the base obtuse to rounded or very slightly cordate, the margin plane to slightly revolute, entire to

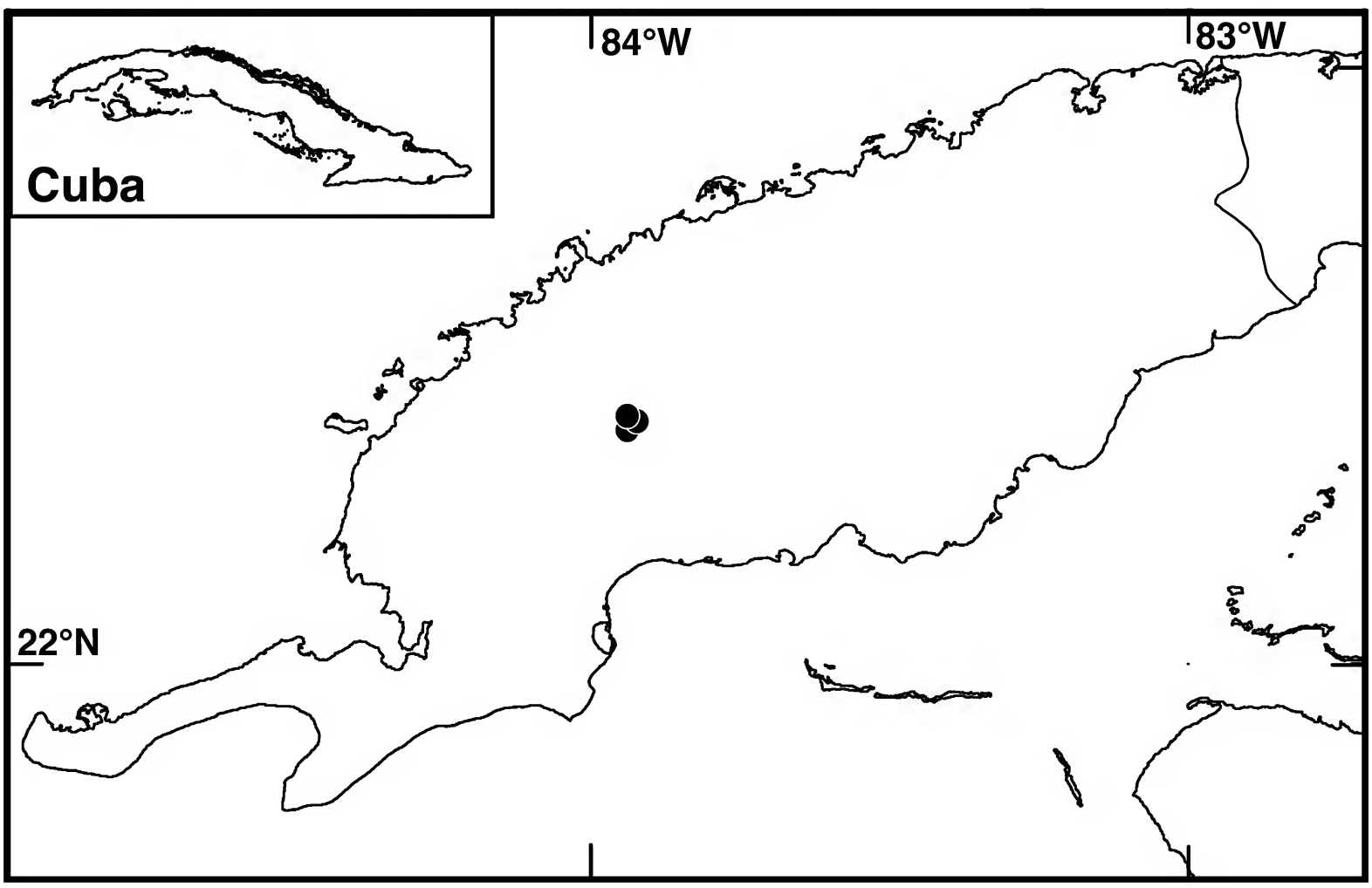


Fig. 2. Distribution of *Miconia karsticola* in Western Cuba.

slightly undulate; secondary veins 2 pairs, one pair conspicuous and one pair inconspicuous, acrodromous, basal or suprabasal, the innermost pair joining midvein at base to 15 mm above the leaf base, the conspicuous secondary veins placed 1.5–12 mm in from margin, the inconspicuous secondary veins intramarginal to 1.8 mm in from margin, tertiary veins percurrent, oriented subperpendicular to midvein, 2–12 mm apart, connected by 1–3 quaternary veins, which are ± reticulate, or not connected by quaternary veins, and separated by composite inter-tertiary vein, the higher order veins reticulate, the midvein and major secondary veins flat to slightly impressed, tertiary veins flat to slightly impressed, remaining veins flat on adaxial surface; the midvein strongly raised, the major secondary veins moderately to slightly raised, the minor secondary veins and tertiary veins slightly raised to flat, and the higher order veins flat on abaxial surface; adaxial surface appearing slightly wrinkled or punctate after drying, with scattered druse crystals, and drying darker than the abaxial surface or sometimes with a distinctive yellowish color when dried, the indumentum initially of dense, pale ferrugineous to translucent, stellate-peltate scales, but quickly glabrescent, although often with a few hairs proximally on midvein, or occasionally even scattered on the surface; abaxial surface pale green but ferrugineous to white due to indumentum, the epidermal surface smooth, with dense ferrugineous to white, or translucent, stellate-peltate scales, 0.13–0.28 mm across, the veins with similar scales, such scales on lamina persistent to ± deciduous, and persistent to deciduous on the primary to tertiary veins, and lamina surface occasionally sticky; mite domatia present or absent, usually (when present) at junction of midvein and major secondary veins, but sometimes also at junction of midvein and minor secondary veins, junction of tertiary veins and midvein, and/or junction of tertiary veins and major secondary veins, composed of elongate, multicellular, ± ferrugineous, yellow to reddish, eglandular, barbate hairs, 0.2–1.6 mm long. **Inflorescences** terminal, paniculate cymes, 3.5–19 cm long, 2–13.5 cm across, with (1–) 2–6 major branch pairs, the peduncle 1–6.7 cm long, the ultimate axes (pseudopedicels) 1.5–7 mm long, and the numerous flowers well separated from each other; bracts 0.3–8.5 x 0.15–1 mm, triangular or narrowly triangular to linear, with acute to rounded apex, quickly deciduous; bracteoles 0.3–0.6 × 0.15–0.3 mm, narrowly triangular, with acute apex, deciduous. **Flowers** 5- or

less commonly 6-merous, zygomorphic (due to positioning of the stamens), with pedicel 1–3 mm long. **Hypanthium** 3.7–7.5 mm long, terete and moderately to not at all constricted above ovary, the free portion 2–4 mm long, 2–3.5 mm wide at the torus, the outer surface with sparse to dense stellate-peltate scales (and sometimes sticky), the internal surface smooth to very slightly longitudinally ridged, glabrous. **Calyx** lobes 5 or 6, separate (and valvate or open) in bud, the tube 0.5–2 mm long, not tearing between lobes (but rarely with a few irregular tears), with moderate to dense stellate-peltate scales abaxially, and sparse to moderate branched to stellate-peltate scales adaxially, the lobes obsolete or 0.1–1 × 1.5–3 mm, obsolete (with a rim-like calyx) or obscurely to clearly developed, ± broadly triangular to triangular, the apex rounded to obtuse or acute, with hairs similar to those of the tube, green, but often red-tinged or red; calyx teeth absent or present, 0–0.3 mm long, round or ellipsoidal bump (near apex of lobes), green, often red-tinged or red, with rounded to acute apex, and hairs similar to those of calyx. **Petals** 5 or 6, 5–11.5 × 2.7–6.7 mm, asymmetrically obovate, spreading, white, occasionally red-tinged, glabrous but both surfaces densely papillose-granulate, the apex rounded, ± shallowly notched, the base slightly narrowed to a broad attachment, the margin entire. **Stamens** 10 or 12, isomorphic, ± geniculate near filament apex; staminal filament 4–8 mm long, glabrous, pale yellow, occasionally pink-tinged, anther thecae 4.5–7.3 × 0.8–1.5 mm, subulate, straight to slightly incurved, opening by a small dorso-apical pore, yellow, the connective not prolonged below the thecae, glabrous, but the filament emerging from slight depression in sterile, minutely dorso-lobed anther base. **Ovary** 3-locular, 2/3–4/5 inferior, ellipsoidal to oblong or ovoid, 3–5 mm long, 1.5–4 mm in diameter, apically cylindric-conical, glabrous, the apex with short, slightly ridged collar but lacking crown, with axile placentation, the ovules numerous, borne on slightly expanded placenta that extends only slightly into locule; style 8–18 mm long, distally curved, white to rose, glabrous; stigma punctate, minutely papillose, ca. 0.15 mm wide. **Berries** 5–14 mm long, 4–14 mm in diameter, globose to ellipsoid, purple-black, with scattered stellate-peltate scales hairs, the hypanthium constricted, 1.5–2.3 mm wide at narrowest point and 2–3.5 mm wide at torus, but appearing strongly constricted due to flaring calyx tube. **Seeds** 1–1.9 mm long, angular-obovoid, with ± rectangular raphe, the testa completely smooth, or smooth on flattened distal surface, and ± slightly roughened on the sides, due to slightly bulging cells; appendage absent.

1. Stems and inflorescence axes without elongate, eglandular hairs _____ var. **bicolor**
1. Stems and inflorescence axes with elongate, eglandular hairs _____ var. **patenti-setulosa**

2a. Miconia bicolor (Mill.) Triana var. **bicolor,** Trans. Linn. Soc. London 28:103. 1872. (**Figs. 1D, 3A, B**). *Melastoma bicolor* Mill., Gard. Dict., ed. 8, no. 6. 1768. *Tetrazygia bicolor* (Mill.) Cogn. in A. de Candolle & C. de Candolle, Monogr. Phan. 7:724. 1891. Type: Loc. Natalis [country unknown], *P. Miller s.n.* (lectotype, designated here, following the suggestion of W.T. Gillis, annotation on sheet, 19 Jun 1973, BM, on-line image #001008022!).

Melastoma pallens Spreng., Neue Entdeck. Pflanzenk. 3:62. 1822. *Miconia pallens* (Spreng.) Triana, Trans. Linn. Soc. London 28:103. 1872. *Tetrazygia pallens* (Spreng.) Cogn. in a A. de Candolle & C. de Candolle, Monogr. Phan. 7:724. 1891. Type: Hispaniola (not seen).

Naudinia argyrophylla A. Rich. in R. de la Sagra, Hist. Phys. Cuba, Pl. Vasc. 10:265. 1845. *Tetrazygia angustiflora* (Benth.) Griseb. var. *argyrophylla* (A. Rich.) Griseb., Fl. Brit. W.I.: 254. 1860. *Miconia angustiflora* (Benth.) Griseb. var. *argyrophylla* (A. Rich.) M. Gómez, Dicc. Bot. Nombres Vulg. Cub. Puerto-Riquenos: 42. 1889. *Tetrazygia argyrophylla* (A. Rich.) Millsp., Publ. Field Columbian Mus., Bot. Ser., 1(6):431. 1900. Type: CUBA [Prov. Pinar del Río]: Vuelta de Abajo, *J.M. Valenzuelas s.n.* (P?, not seen, and if lost could be typified by t. 44(1) in de la Sagra, 1850).

Naudinia chrysophylla A. Rich. in R. de la Sagra, Hist. Phys. Cuba, Pl. Vasc. 10:266. 1845. Type: CUBA [Prov. Pinar del Río]: Vuelta de Abajo, in locis altis montium (P?, not seen).

Tetrazygia acunae Borhidi, Acta Bot. Acad. Sci. Hung. 23:38. 1977 [1978]. Type: CUBA. Prov. Oriente [Prov. Santiago de Cuba]: Sierra Maestra, Pico Turquino, Jul 1936, fr, *J. Acuña 19452* (holotype: HAC!), non *Miconia acunae* Borhidi, Növenyrendsz Novényfäldr. Tansz. Eötrös Loránd Tudományegyet. Budapest 4:23. 1976.

Stems and inflorescence axes lacking elongate, multicellular, eglandular hairs.

Chromosome number.—$2n = 34$ (Solt & Wurdack 1980).

Phenology.—Flowering has been recorded in every month of the year.

Distribution and ecology.—*Miconia bicolor* var. *bicolor* occurs natively in southern Florida (Miami-Dade Co.), the Bahamas (Andros, Eleuthera, Grand Bahama, Great Abaco, and New Providence Islands), western Cuba

Fig. 3. **A, B**: *Miconia bicolor* var. *bicolor*: **A.** Inflorescence. **B.** Flower (plants in cultivation, Florida). **C, D**: *M. guajaibonensis*: **C.** Plant with young inflorescences. **D.** Flower (*Bécquer & Abbott 82431*). **E.** *M. impressa* (*Ekman 17539*).

(mainly in Prov. Pinar del Río, Isla de la Juventud), central Cuba (mainly in Prov. Cienfuegos, Sancti Spíritus, and Villa Clara) and, less commonly, the "Oriente" region (Prov. Guantánamo, Holguín and Santiago de Cuba), and on Hispaniola (widespread in the Dominican Republic and Haiti), growing in thickets or coppice, moist to dry broadleaved forests, and open to dense pine forests, pine and/or palm savannas, or disturbed habitats, on limestone, serpentine, or gravely to sandy soils, from near sea-level to 1200 m (Fig. 4). The species has been introduced into Hawaii, where it is locally naturalized in mesic to wet forests near Hilo (Wagner et al. 1990).

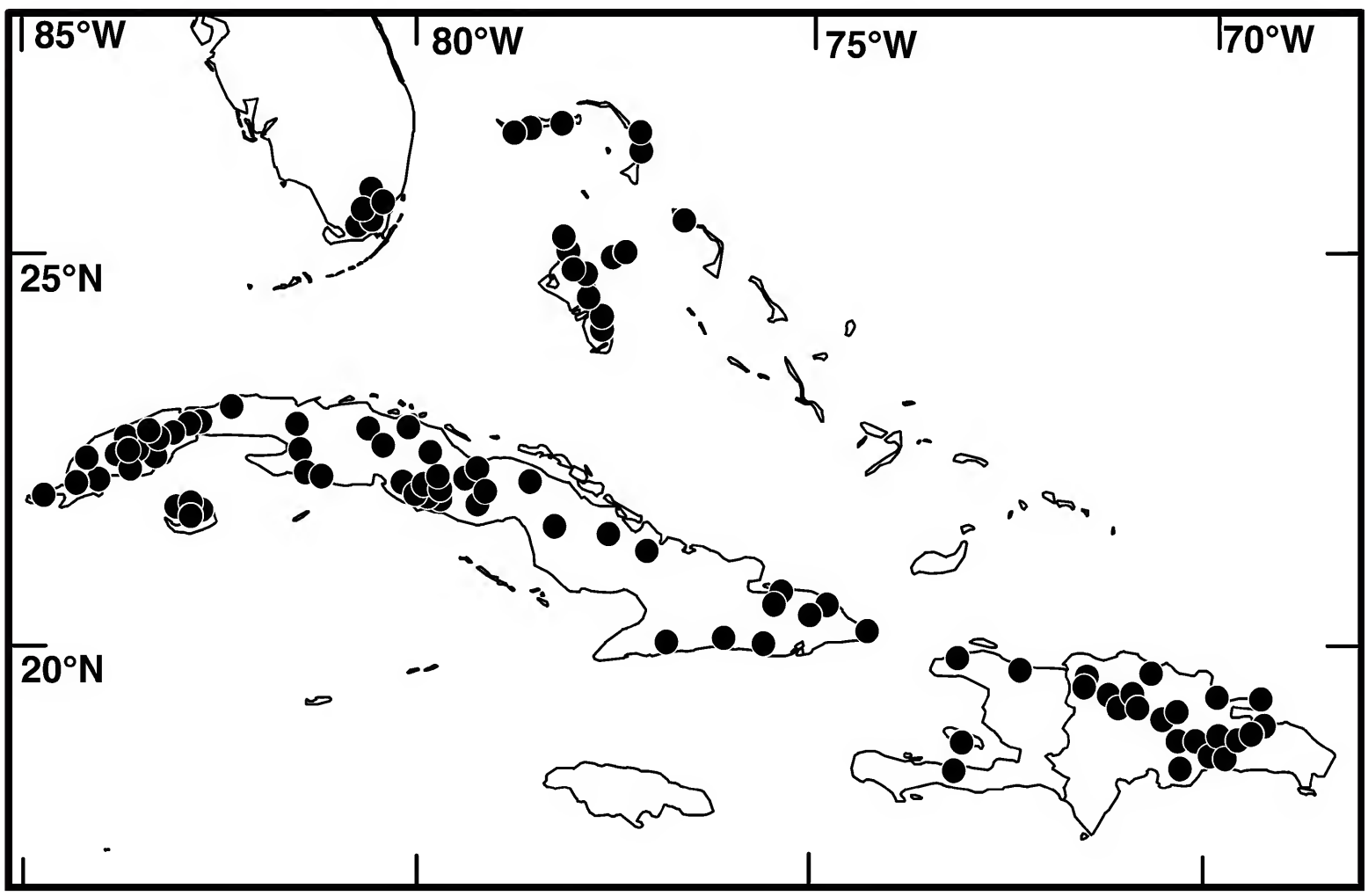


Fig. 4. Distribution of *Miconia bicolor*.

Additional specimens examined: **BAHAMA ISLANDS. Andros:** Mangrove Cay, 18 Aug–10 Sep 1906, *Brace 4960* (NY, US); Nicholl's Town, 5–6 Mar 1907, *Brace 6733* (NY); N of Love Hill, 29 Jan 1974, *D.S. Correll & Godfrey 41267* (FTG); S part of island, W end of airstrip, 24 Sep 1974, *D.S. Correll 43527* (FTG, NY); just S of Stafford Creek Bridge, 5 Dec 1976, *D.S. Correll & Proctor 47757-B* (FTG); 16–18 mi S of Andros Town on Fish Camp rd, 2 Mar 1966, *Dawson 26653* (DUKE, US); Coakley Town to Calabash Bay, 8 Mar 1966, *Dawson 26799* (US); Congotown District, E bank of South Bight, 5 mi S of Drigg's Hill jetty, 19 Mar 1986, *Eshbaugh & Wilson 86-75* (FTG); 2 mi N of Fresh Creek, 16 Mar 1966, *Gillis 6101* (MSC); along Queen's Hwy, 100 m S of Stafford Creek bridge, near Forfar Research Station, 27 Feb 1976, *Gillis 12859* (MSC); Forfar Field Station, town of Stafford Creek, 24°53'51"N, 77°55'56"W, 20 Jul 2002, *Goldman 2458* (FTG, GH); 2 mi NW of Love Hill, 24 May 1975, *Hill 3044* (FTG); near IFS Field Station, near Blanket Sound settlement, 15 Jul 1990, *Kjellmark 15* (DUKE); ibid., 0.5 mi S of main rd, 20 Jun 1991, *Kjellmark 58* (DUKE, MO); near San Andros Motel, 13 Jun 1987, *Nickrent 2644* (NY); Nicols Town, May 1890, *J.I. & A.R. Northrop 127a* (GH); Mangrove Cay, 8 May 1973, *Popenoe 194* (FTG); near Lisbon Creek, Mangrove Cay, 16–19 Jan 1910, *Small & Carter 8468* (GH, NY, US). **Eleuthera:** Harbour Island to Lower Bogue, 18 Feb–4 Mar 1907, *E.G. Britton 6443* (NY); near turnoff to the Bluff from rd to Ridley Head, 8 Jan 1974, *D.S. Correll 41034* (FTG, NY); just E of The Bluff, 12 Jan 1974, *D.S. Correll 41207* (FTG); along Queen's Highway, N of Lower Bogue, 7 Apr 1978, *D.S. & H.B. Correll 49551* (FTG, NY). **Grand Bahama:** Queens Way, W of Freeport, 18 Mar 1971, *Austin & Conroy 4587* (FTG, NY); 7 mi NE of Freeport, 12 Feb 1966, *Beckner 824* (FLAS); Eight Mile Rocks, 5–13 Feb 1905, *N.L. Britton & Millspaugh 2451* (NY); Gold Rock Creek, near E end of island, 28 Apr 1951, *Carr s.n.* (FLAS); Gold Rock Creek, near High Rock, 14 Sep 1951, *Carr s.n.* (FLAS, GH); near jct of Sandcombe Rd and Grasmere Dr, Freeport, 4 Nov 1973, *D.S. Correll 40481* (FTG); intersection of Settlers Way and East Mall, Freeport, 14 Aug 1974, *D.S. Correll & Kral 42816* (FTG, NY); Rand Memorial Park Nature Center Preserve, 1.5 mi from Freeport along Settlers Way, 31 Mar 1969, *Gillis 7758* (FTG). **Great Abaco:** Marsh Harbor, 9 Dec 1904, *Brace 1600* (NY); NW edge of Marsh Harbour, 15 Jun 1981, *D.S. Correll & Wasshausen 52032* (FTG, US); N of Coopers Town, 26°53.978'N, 77°33.097'W, 17 May 2000, *Freid 00-070* (FTG); Abaco National Park, 7 Jun 2004, *Freid 04-023* (FTG, NY); 1 mi E of airstrip at Marsh Harbour, 28 Mar 1966, *Perry 1776* (DUKE); 0.5 mi N of Dundas Town, 14 Dec 1979, *Wunderlin et al. 8265* (FLAS, GH, MO); main rd, 2.9 mi S of Wilson City rd, 16 Dec 1979, *Wunderlin et al. 8524* (GH, MO). **New Providence:** without definite locality, 2 Feb 1877, *Brace 465* (NY); Killarney pine barrens, 12–24 Mar 1907, *E.G. Britton 6536* (NY, US); Blue Hills Rd, 7–8 Apr 1904, *N.L. Britton 8* (NY); Farringdon Rd, 24 Aug 1904, *N.L. Britton & Brace 232* (NY); near Nassau airport, 19 Apr 1971, *Burch 4204* (MICH, MO, NY); without definite locality, 1859, *Cooper 82* (GH, NY); Thompson Blvd. near Portago Rd, Nassau, 23 Mar 1977, *D.S. & H.B. Correll 48265* (FTG, NY); Garden Hill Estates, Blue Hill area, Nassau, 4 Jun 1976, *D.S. Correll 47225* (FTG, NY); near Nassau, Jan–May 1903, *Curtiss 41* (A, GH, HAC, MIN, NY, P on-line image, US); near Harrold and Wilson Ponds, 21 Feb 1946, *Degener 18801* (GH, NY); S of Prospect Ridge, Nassau, 15 Feb 1946, *Degener 18836* (GH, NY); in pinetis, 22 Feb 1888, *Eggers 4180* (MICH, NY, P on-line image, US); W end of island, 23 Mar 1963, *Gillis 5347* (MSC); SW corner of island, 1 mi SW of Lyford Cay, 7 Jul 1969, *Gillis 8350* (FTG); along

Coral Harbour Rd, 4 May 1970, *Gillis 9202* (FTG); pinelands, 3 Jul 1948, *Ledin 268* (FTG); ibid., 18 Aug 1948, *Ledin 315* (FTG); Nassau, 15 Jan 1890, *J.I. & A. R. Northrop 127b* (NY); S of Windsor Airport, W of Nassau, 2 Apr 1965. *Perry 1620* (DUKE); without definite locality, 3–5 Sep 1952, *von Reis 231* (MICH, US); N of Winsor Field, 77°28.5'W, 25°3.5'N, 13 Jul 1960, *Webster et al. 10457* (DUKE, US); 1 mi S of Nassau, 24 Feb 1905, *Wight 128* (GH, NY); Grantstown, 28–29 May 1909, *Wilson 8171* (NY). **CUBA. Prov. Camaguey:** Céspedes, El Quemado, 15 May 1915, *Roig et al. H-ROIG 898* (HAC); Queen City to Minas, 21 Nov 1909, *Shafer 2925* (F, NY, US). **Prov. Ciego de Ávila:** Sierra de Judas, Cunagua, 1–7 Aug 1985, *Cano O. & Herrera 146 SV-34725* (HAC). **Prov. Cienfuegos:** Cumanayagua, Sierra del Escambray, subida al Pico San Juan, 7 Nov 1987, *Arias et al. HFC-62964* (HAJB); ibid., en el camino entre Los Tornos y El Naranjo, 3 Nov 1987, *Arias et al. HFC-62782* (HAJB); ibid., lomas alrededor de Los Tornos, 4 Nov 1987, *Arias et al. HFC-62809* (HAJB); ibid., San Blas, 300–400 m, 5 Aug 2004, *Bécquer et al. HFC-83168* (HAJB); ibid., Las Vegas entre el cafetal y San Blas, cafetal de Buenos Aires, 29 Oct 1985, *Berazaín et al. HFC-58009* (HAJB); ibid., 8 Oct 1986, *González L. et al. HFC-60246* (HAJB); Cumanayagua, Sierra del Escambray, loma al sur de Pico San Juan, 700–800 m, Nov 1975, *Bisse et al. HFC-28707* (HAJB); Cieneguita, 7 Jun 1895, *Combs 128* (F, GH, MICH, MO, NY, P on-line image); Cumanayagua, Complejo San Juan, 2 Nov 1986, *Exp. Conjunta P. Herrera et al. SV-35912* (HAC); Las Lagunas, Buenos Aires, 2500 ft, 6 Dec 1928, *Jack 6884* (A, NY, P on-line image, US); Soledad, Cienfuegos, 30 Mar 1936, *Jack 8758* (GH, P on-line image). **Prov. Habana:** al E de playa Baracoa, 23 Oct 1966, *Bisse HFC-189* (HAC); Loma La Pita, entre Campo Florido y Jaruco, 31 Nov 1974, *Bisse et al. HFC-25316* (HAJB). **Prov. Guantánamo:** Imías, Maisí, Tres Piedras, 700–900 m, 27 Jul 1984, *Álvarez et al. HFC-55049* (HAJB); pinar de Monte Cristi, 500–600 m, Jun 1967, *Bisse & Rojas HFC-3614* (HAJB); Monte Cristi, 700 m, May 1968, *Bisse & Köhler HFC-9327* (HAJB); Felicidad de Yateras, en la zona de Monte Cristi, 23 Aug 1971, *Bisse HFC-20223* (HAJB); orillas del río Baez, cerca del campamento "Los Naranjos", 1–3 Aug 1975, *Bisse et al. HFC-26997* (HAJB); aserrío Nuevo Mundo, al S del aserrío, 300 m, Apr 1975, *Bisse et al. HFC-25816* (HAJB); Felilcidad de Yateras, Pinar de Monte Cristi, 700 m, 13 May 1983, *Bisse et al. HFC-49401* (HAJB); al S de la Reservación de Cupeyal, 11 Feb 1970, *Borhidi et al. SV-35467* (HAC). **Prov. Holguín:** Sierra Cristal, valle del río Lebisa desde Mandinga hacia arriba, Apr 1968, *Bisse & Köhler HFC-7412* (HAJB). **Prov. Isla de la Juventud (Isla de Pinos):** Sta. Fé, John Jungle, 19–22 Jun 1922, *Acuña SV-22673* (HAC); camino de cayo Piedras a Punta del Este, 4 Nov 1981, *Álvarez et al. HFC-45623* (HAJB); camino hacia Puenta del Este, desde Cayo Piedras, 13 Apr 1974, *Areces & Berazaín HFC-24876* (HAJB); Reserva Ecológica "Los Indios", centro-oeste de la isla, al N del Hotel Colony entre el río Los Indios y el río Itabo, por el sendero ecológico desde la Estación Ecológico, 0–5 m, 31 Mar 2008, *Bécquer et al. HFC-85059* (HAJB); Nueva Gerona, cerca del Motel Rancho del Tesoro, 22 Dec 1966, *Bisse HFC-723* (HAJB); orillas de la laguna Santa Bárbara, 23 Dec 1966, *Bisse HFC-881* (HAJB); cerca de las Delicias, 23 Jul 1971, *Bisse HFC-19828* (HAJB); camino de cayo Piedras a Punta del Este, 24 Jul 1971, *Bisse HFC-19848* (HAJB); ibid., 23 Oct 1976, *Bisse et al. HFC-32751* (HAJB); Sierra de la Cañada, 50–200 m, 1 May 1970, *Bisse et al. HFC-26297* (HAJB); near Nueva Gerona, 5 Apr 1904, *Curtiss 414* (F, GH, HAC, MIN, NY, P on-line image, US); Santa Bárbara, 3 Nov 1920, *Ekman 12104* (S); vicinity of Nueva Gerona, 6 May 1910, *Jennings 57* (NY); arroyo E of Los Indios, 18 May 1910, *Jennings 347* (GH); along rd to San Francisco de las Piedras, 10 Feb 1955, *Killip 44741* (GH, HAC, US); rd from Nueva Gerona to Santa Bárbara, 19 Nov 1955, *Killip 45110* (US); 2.5 km NW of Santa Bárbara on rd to Westport, 26 Jan 1956, *Killip 45471* (HAC, US); near Nueva Gerona, 30 Jun 1900, *Palmer & Riley 906* (NY); Sta. Fé, Hacienda San Juan, 12 Aug 1919, *Roig & Cremata SV-7117* (HAC); without definite locality, 25 Jun–10 Jul 1901, *Taylor 138* (GH); ibid., *Taylor 138b* (F, MO, NY, US); ibid., *Taylor 139* (F, GH, MO, NY, US). **Prov. Las Tunas:** Cerro de Dumañuecos, near Manatí, 31 Mar 1939, *Bros. León & Alain 18914* (GH, NY). **Prov. Matanzas:** Sabana de Cascajal, 30 Sep 1947, Acuña SV-14784 (HAC); Sabanas de Lacret, casi en el límite con Las Villas, 30 Sep 1954, *Bro. Alain 4055* (GH, HAC); Jovellanos, San Miguel de los Baños, alrededores Loma Jacán, 21 Dec 1976, *Berazaín et al. HFC-33581* (HAJB); Playa Girón, monte seco, Nov 1967, *Bisse & Rojas HFC-4683* (HAJB); Playa Larga, península de Zapata, montes entre Caletones y Santo Tomás, 19 Feb 1977, *Bisse et al. HFC-34499* (HAJB); Aguada de Pasajeros, sabana al N del km 193 de la Autopista Nacional, 11 May 1984, *Bisse et al. HFC-54772* (HAJB); Ciénaga de Zapata, Batey Casa Nueva, 7 Jun 1978, *Oviedo et al. SV-30513* (HAC). **Prov. Pinar del Río:** Alturas Pizarrosas del Sur, Zona de Pizarras a lo largo de la carr. Entre Pinar del Río y Viñales, km 12–15, 22°50'N, 83°42'W, 140 m, 7 Jul 1993, *Acevedo-Rdgz. et al. 5705* (HAC); Viñales, Santo Tomás, May, *Acuña SV-9917* (HAC); San Vicente, Valle del Ancón, 2 Jun 1953, *Acuña & Correll SV-18664* (HAC); pinares prox. a Viñales, 30 Nov 1947, *Acuña SV-22688* (HAC); Sabanalamar, El Sábalo, Finca Fueyo, 2–5 Apr 1950, *Bro. Alain 1335* (HAJB, NY); entre San Vicente y El Ancón, 17 Mar 1957, *Bro. Alain & Proctor 6187* (HAC); Guanae, El Pitirre, en el terraplén desde Hermanos Barcón hasta la carretera de la Coloma, 19 Oct 1983m *Álvarez et al. HFC-50957* (HAJB); Bahia Honda, Sierra de Cajálbana, subida al Tecnológico Invasión de Occidente, 300 m, 15 Jul 1989, *Álvarez & Pujadas A. HFC-70164* (HAJB); Sandino, Carabelita, costa entre La Barca y el entronque de Carabelita, Guanahacabibes, 22 Nov 1973, *Areces A. s.n.* (HAJB); Herradura, 20 Sep 1904, *Baker SV-2145* (F, GH, HAC, HAJB, NY, US); ibid., 10 Apr 1905, *Baker & Diminoch SV-4860* (HAC, HAJB); ibid., 10 Apr 1905, *Baker SV-5086* (HAC); Corral Viejo, cerca de la laguna vieja de Santa Teresa, 5–10 m, 6 May 2004, *Bécquer & Abbott HFC-82286* (FLAS, HAJB); Guane, El Sábalo, pinares de Sabanalamar, al S del pueblo, 5–20 m, 3 Apr 2001, *Bécquer & Veloso HFC-79848* (HAJB); Viñales, pinares alrededores de la carretera entre el entronque Ancón y el valle Ancón, 200–300 m, 13 Nov 2002, *Bécquer & Veloso HFC-81071* (HAJB); Sandino, potreros cerca de La Fé, 6 May 2006, *Bécquer & Morejón R. HFC-83986* (HAJB); Sanadino, San Ubaldo, reserva florística, 8 May 2006, *Bécquer &Morejón HFC-84011* (HAJB); Viñales, Moncada, Alturas de Pizarras del Sur, pinares al S de la Escuela de Espeleología, 11 May 2006, *Bécquer & Morejón R. HFC-84044* (HAJB); Guanes, cerca de La Fé, Mar 1967, *Bisse & Rojas HFC-1805* (HAJB); Guanes, laguna de Los Indios, Mar 1967, *Bisse & Rojas HFC-1833* (HAJB); Guanes, península de Guanahacabibes, Mar 1967, *Bisse & Rojas HFC-3078* (HAJB); La Palma, pinares al N de San Andrés, Dec 1967, *Bisse & Rojas HFC-4950* (HAJB); San Diego de los Baños, pinares al N de la Sierra de la Guira, Jul 1968, *Bisse et al. HFC-9534* (HAJB); Viñales, pinares al S del pueblo, 16 Nov 1968, *Bisse & Lippold HFC-9646* (HAJB); ibid., *Bisse & Lippold HFC-9702* (HAJB); Viñales, pinares al S del pueblo, Nov 1986, *Bisse & Lippold HFC-10866* (HAJB); Las Ovas, lagunas al NO del pueblo, 1970, *Bisse & Lippold HFC-17390* (HAJB); La Guira, las Bermejales, al N de la Sierra de Guira, 200–300 m, Dec 1970, *Bisse & Lippold HFC-18380* (HAJB); Viñales, cañada de un arroyo en los pinares al SO del pueblo, Dec 1974, *Bisse et al. HFC-26430* (HAJB); lagunas al SO de Las Ovas, 5 Apr 1976, *Bisse et al. HFC-31122* HAJB); Sumidero, cerca de la confluencia de arroyo Cayo

Malo y arroyo Camarones, 12 Dec 1978, *Bisse et al. HFC-38545* (HAJB); Mantua, monte al E de la desembocadura al arroyo Camarones, 27 Mar 1982, *Bisse et al. HFC-43361* (HAJB); Las Ovas, laguna, 4 km al SO del pueblo, 50 m, 31 Mar 1982, *Bisse et al. HFC-46704* (HAJB); San Luis, Las Llanadas, 50 m, 19 Dec 1982, *Bisse et al. HFC-48582* (HAJB); Minas de Matahambre, Sumidero, zona Cejas de Francisco, 20 Jan 1984, *Bisse et al. HFC-51457* (HAJB); Mantua, las Clavellinas, cayo Ciénaga del Prado, 16 May 1984, *Bisse et al. HFC-54448* (HAJB); brazo del río Frío al E de Mantua, 24 Nov 1975, *Borhidi & Capote SV-32857* (HAC); Sandino, península de Guanahacabibes, 25 Oct 1975, *Borhidi & Delgado F. HPR-4185* (HAJB); vicinity of Herradura, 26–30 Aug 1910, *N.L. Britton et al. 6603* (NY, US); San Diego de los Baños, 31 Aug–3 Sep 1910, *N.L. Britton et al. 6746* (NY, US); vicinity of Pinar del Río, 5–12 Sep 1910, *N.L. Britton et al. 7116* (NY); près de Viñales, 22°37'N, 83°3'W, 130 m, 17 Jun 1990, *Dechamps et al. NH:12468 TW:49941* (MO); Municipio Las Ovas, Reserva Natural de El Punto, 83°33'W, 22°21'N, 10 Mar 1997, *Dressler 192* (F); Herradura, 30 Mar 1907, *Earle 656* (F, NY, US); ibid., 16 Aug 1907, *Earle 730* (NY); Santa Barbara, 5 Dec 1901, *Earle s.n.* (NY); Herradura, 12 Apr 1920, *Ekman 10774* (S); S of Las Mangas, 25 Jul 1921, *Ekman 13066* (S); Herradura, 27 Oct 1923, *Ekman 17791* (NY, S); Consolación del Sur, Hato de las Vegas, El Tablazo, 26 May 1918, *Fortún & San Pedro SV-6887* (HAC); Consolación del Norte, Jun 1920, *Ganganelli R-ROIG 2076a* (HAC); Sandino, San Ubaldo, laguna del Toro, 30 Jan 1985, *González L. et al. HFC-55343* (HAJB); La Fé, 7 Jan 1971, *Grudzinskaya & Imchanitzkaja 768* (HAC); Consolación del Sur, Autopista Nacional entre Entronque de Herradura y foresa San Diego, 7 Feb 1992, *Gutiérrez HFC-70380* (NY); Viñales, en el km 13, alrededores de la carretera de Viñales a Pinar del Río, 9 Feb 1991, *Gutiérrez J. & Panfet C. HFC-69550* (HAJB); vicinity of San Diego de los Baños, 5 Jul 1915, *Bro. León LS-5155* (HAC, NY); SE of Los Palacios, 7 Aug 1917, *Bro. León & M. Roca LS-7377* (NY); entre Mangas y Candelaria, 27 Jan 1931, *Bro. León LS-14766* (HAC, NY); S of Herradura, 7 Apr 1933, *Bro. León LS-15936* (HAC, NY); Sabana cerca de Corojal, Laguna de Piedras, Candelaria, Apr 1937, *Bro. León 16820* (HAC, NY); San Luís, Sabana de Santa Marta, 1 May 1940, *Bro. León et al. LS-17821* (HAC); Laguna de Piedras, Mangas, 2 Mar 1939, *Bro. León LS-18898* (HAC, NY); la Laguna de Piedras, Mangas, 20 May 1941, *Bro. León 20078* (GH, HAC, NY); cercanías de La Fé, Feb 1942, *Bros. León & Marie-Victorin LS-20497* (HAC, NY); montes cerca de la Jaula, 23 Feb 1977, *Lepper L. et al. HFC-34367* (HAC, HAJB); Lagune de la Maquina, 4 Mar 1943, *F. Marie-Victorin 58352* (GH); near Pinar del Río, 24 Feb 1900, *Palmer & Riley 49* (US); near Coloma, 18 Mar 1900, *Palmer & Riley 352* (US); Ancón, vereda de mina del Gato, a orillas del río Sajanal, 28 Jun 2007, *Panfet C. HFC-85610* (HAC); without definite locality, Jul 1910, *Ponce & Ramos H-ROIG 257* (HAC); 4 mi E of Candelaria, 16 Mar 1957, *Proctor 16293* (A); Consolación del Sur, 29 Nov 1915, *Roig & Van Hermann SV-6377 H-ROIG 1128* (HAC); San Diego, La Guira, Apr 1966, *Samek V. SV-26081* (HAC); without definite locality, 23 Apr 1903, *Shafer 274* (HAC, NY); Herradura to railroad, then to Paso Real, 11 Jan 1912, *Shafer 11785* (A, F, MO, NY, US); ibid., *Shafer 11787* (NY); Los Palacios to San Juan de Zayas, 17 Jan 1912, *Shafer 11807* (A, F, MO, NY, US); ibid., *Shafer 11809* (A, MO, US); San Juan y Martinez, cayo Ratones, 15 Feb 1989, *Urquiola et al. HPR-5091* (HAJB); Ovas, El Punto, 5 Feb 1990, *Urquiola et al. HPR-5811* (HAJB); Herradura, 1904, *Van Hermann SV-270* (NY, P on-line image, US); ibid., 1905, *Van Hermann SV-560* (NY, P on-line image); ibid., 1905, *Van Hermann SV-573* (NY); ibid., 1905, *Van Hermann SV-596* (NY); ibid., 26 Aug 1905, *Van Hermann SV-773* (HAC); ibid., 10 Sep 1905, *Van Hermann SV-867* (HAC); ibid., 21 Mar 1906, *Van Hermann 2780* (A, GH, HAC, US); ibid., 23 Jan 1905, *Van Hermann SV-4478* (HAC); Puerta de Golpe, 27 Jan 1915, *Van Hermann SV-5849* (HAC); entre Candelaria y Artemisa, 17 Sep 1904, *Wilson 1713* (HAC, HAJB, NY); Vueltabajo, 23 Jul, and Retiro [near Taco Taco], 22 Jun, *Wright 1222 p.p.* (GH, NY, S); Retiro [near Taco Taco and possibly other localities], June, *Wright 1222a* (GH, NY, P on-line image, US); Retiro [near Taco Taco], 21 Jun, and Vueltabajo, 24 Jul, 1860–1864, *Wright 2507* (GH, HAC, MO); Los Remales, 1660–1864, *Wright s.n.* (GH); without definite locality, *Wright s.n.* "308", 1863 (S); ibid., 1865, *Wright s.n.* (S); ibid., *Wright s.n. "980"* (HAC); ibid., *Wright s.n.* (HAC); San Julián, granja Sandino, Feb 1966, *Yero M. SV-25996* (HAC); Viñales, cerca del camino, 9 Jun 1995, *Yero D. HFC-81190* (HAJB). **Prov. Sancti Spíritus:** Sierra del Escambray, Topes de Collantes, Mogote mi Retiro, 79°50'W, 22°22'N, 850 m, 2 Jul 1993, *Acevedo-Rdgz. et al. 5593* (HAC, US); Trinidad, Topes de Collantes, Pico Potrerillo, 750–950 m, 13 Apr 1991, *Álvarez & Gutierrez HFC-69444* (HAJB); falda S de las lomas de Banao, *Areces et al. HFC-28997* (HAC, HAJB); Banao, camino entre el monument de Cantú y el tope de La Diana, 26 Oct 1986, *Arias et al. HFC-59737* (HAJB); Jatibonico, El Patio, alrededor de la laguna Botijuela, 12 Feb 2002, *Bécquer & Veloso HFC-79904* (HAJB); Sierra del Escambray, loma al O de la carretera, 5 km al S de Topes de Collantes, 600 m, 7 Nov 1968, *Bisse & Lippold HFC-9662* (HAJB); Fomento, camino entre Santa Teresa y Gavilanes, 8 Nov 1979, *Bisse et al. HFC-41022* (HAJB); ibid., *Bisse et al. HFC-41023* (HAJB); Fomento, valle del arroyo Gavilancito, 300–400 m, 10 Nov 1979, *Bisse et al. HFC-41077* (HAJB); Trinidad Mts, slopes of Pico Potrerillo, 700–900 m, 12 Jun 1922, *Ekman 13999* (F, S, US); Cabaiguán, El Arriero, 28 Jul 1918, *Fortún SV-6927* (HAC); Trinidad, El Tibisial, alrededores de loma Gavilanes, 29–30 Sep 2002, *Gutiérrez et al. HFC-80247* (HAJB); Loma de la Jagua, Los Helechales, Banao, 10 Aug 1915, *Bros. León & Clement LS-5395* (HAC, HAJB, NY); from Trinidad to Tope de Collantes, Jul 1938, *Bro. León LS-18430* (GH, HAC, NY); Loma de la Gloria, Banao Mts, 29 Jul 1918, *Bro. León & M. Roca LS-8003* (HAC, NY); Lomas de Banao, May 1920, *Luua 591* (F, HAC); Loma Caballete de Casa, 400–700 m, 8 Nov 1979, *Imchanitzkaja & Herrera 448* (HAC). **Prov. Santiago de Cuba:** Gran Piedra, carretera de la Piedra a la Mercedita, 1200 m, 25 May 2004, *Bécquer et al. HFC-82538* (HAJB); Guamá, Mogote Peak [Pico Turquino], 27 Feb 1939, *Bucher 116* (HAC); Guamá, Sierra del Cobre, subida a la loma El Espejo, 30 Apr 1989, *Dietrich H. et al. HFC-67756* (HAJB). **Prov. Villa Clara:** Sabanas de Manacas, 6 Jun 1950, *Acuña & Correl SV-18663* (HAC); Sabanas de Manacas, orillas de la Carretera Central, 13 Apr 1954, *Bro. Alain 4013* (GH, HAC, US); Manacas, al N del pueblo, 19 Nov 1966, *Bisse & Rojas HFC-435* (HAJB); ibid., al S del pueblo, Feb 1967, *Bisse & Rojas HFC-1497* (HAJB); Cartagena, cerca de Santiago, Apr 1967, *Bisse & Rojas HFC-2142* (HAJB); Huff's farm, near Manacas, Jun 1941, *Howard 5500* (GH, NY, US); Placetas del Sur, 29 Jul 1916, *Bro. León LS-6405* (HAC, NY, US); Motembo, 10 Aug 1918, *Bro. León & M. Roca LS-8213* (NY); Sabana de Motembo, 28 Aug 1922, *Bro. León LS-11369* (HAC, NY); near Manacas, 11 Jul 1936, *Smith & Hodgdon 3097* (F, GH, MICH, MO, NY, P on-line image, S, US). **DOMINICAN REPUBLIC. Distrito Nacional:** Sierra de Yamasa, Sierra Prieta, próximo al nacimiento del arroyo Tosa, 80 m, 12 Jun 2005, *Clase & Ángeles 4060* (FLAS); El Manielito, 23 Jan 1929, *Ekman H11313* (S, US); Sierra Prieta, 18.65386°N, 69.9689°W, 120–125 m, 20 Jul 2012, *Jestrow 2012-244* (FLAS); Sierra Prieta, Villa Mella, 150–200 m, 24 Oct 1975, *Liogier 24117* (JBSD, NY); Sierra Prieta, al NE de Villa Mella, camino a Yamasá, a la orilla del arroyo Mina próximo a un potrero, 18°19'N, 69°58'W, 70 m, *Veloz et al. 103* (FLAS, JBSD); Sierra Prieta, NE de Villa Mella, camino a Yamasá, 18°19'N, 69°58'W, 60

m, *Veloz et al. 323* (FLAS, JBSD). **Prov. Dajabón:** Cerro de Chacuey, Partido, Dajabón, 300 m, 18 Aug 1973, *Liogier 20004* (F); Cordillera Central, Municipio de Partido, Cerro de Chacuey, Loma Las Mercedes, 19°26'55.1"N, 71°36'7.9"W, 400 m, 11 May 2005, *Veloz & García 3757* (FLAS, FTG, JBSD); Municipio de Partido, Cerro de Chacuey, entrando por Cajuil, 19°26'31.9"N, 71°34'52.8"W, 385 m, 11 May 2005, *Veloz & García 3821* (JBSD). **Prov. Hato Mayor:** Sabana de la Mar, 8 Jul 1930, *Ekman H15599* (S). **Prov. La Vega:** Cordillera Central, 10 km S de la carretera La Vega – Santiago, en la carretera hacia Jarabacoa, 19°11.5'N, 70°35'W, 490 m, 11 Dec 1995, *García et al. 6067* (F, JBSD, MO); Cordillera Central, 7.5 km NE of Jarabacoa on rd to Bayacanes and La Vega, 630 m, 25 May 1992, *Judd 6623* (FLAS, JBSD); Loma del Puerto, La Vega, 400 m, 18 Jun 1969, *Liogier 15723* (NY, US). **Prov. Maria Trinidad Sanchez:** Los Haitises, La Manaclita, 2 Jul 1930, *Ekman H15528* (A, S, NY, US). **Prov. Monseñor Nouel:** Cordillera Central, SE of Bonao, Falcombridge Dominicana mine, at top of Loma Larga, 650 m, 14 May 1992, *Judd 6516* (FLAS, JBSD); Loma Peguera, Barrancón, from Bonao to Hato Viejo, 200–300 m, 17 Apr 1969, *Liogier 14874* (GH, JBSD, NY, US); Cordillera Central, Falcombridge Dominican mine in the area of Loma Peguera, Loma Larga, on the top, 650 m, 14 May 1992, *Skean 3125* (MICH, MSC); 5 km SE of Banao, at Falconbridge Dominicana Mine, 18°45'N, 70°15'W, 28 Jul 1981, *Watson 1191* (FLAS, FTG); ibid., 29 Jul 1981, *Watson 1264* (FLAS, FTG); SE of Bonao, Loma La Peguera vicinity, Falcombridge Dominicana mine, on Loma Larga, 18°50'N, 70°25'W, 28 Jul 1981, *Zanoni et al. 15665* (FLAS, JBSD, NY, US). **Prov. Monte Plata:** 12.5 km NE de Bayaguana y 3.5 km NW del poblado Trinidad, en el lugar llamado Sabana Larga, 18°50'N, 69°32'W, 190 m, 14 Sep 1987, *García & Pimentel 2347* (FLAS, JBSD); Batey Guanuma, 100 m de la finca experimental de la Univ. "CDEP", 60 m, 31 Jul 1992, *F. Jiménez 583* (FLAS, JBSD); Rincón Dajao on Yamasá rd, 10 mi N of Santo Domingo city, 150 m, 26 Jun 1968, *Liogier 11841* (GH, JBSD, NY, P on-line image, US); Los Haitises, próximo al Río Comate, 1 km NE del poblado Comatillo (al NE de Bayaguana), 18°48'N, 69°36'W, 100 m, 10 May 1991, *Zanoni & F. Jiménez 45222* (FLAS, JBSD). **Prov. Puerto Plata:** Puerto Plata, Samanas rd, 10 Feb 1871, *Wright et al. 522* (US). **Prov. Samaná:** Península de Samaná, Cabo Cabrón, 100 m, 12 Nov 1993, *Salazar et al. 1260* (FLAS, JBSD). **Prov. San Cristobal:** 30 km from Santo Domingo City on Duarte Highway, 28 Jun 1972, *Liogier 18648* (F, JBSD, NY, US). **Prov. Sanchez Ramirez:** Campamento Los Pinos, Maimón, 250 m, 31 May 1977, *A. & P. Liogier 26656* (JBSD, MO, NY, US). **Prov. Santiago:** Cordillera Central, Municipio San José de las Matas, sección Los Ramones, en las carretera hacia Monción, después de Jicomé, 689 m, 20 Aug 2011, *Clase et al. 6896* (FLAS, JBSD); Jicomé, San Jose de las Matas, 600–700 m, 21 Jun 1933, *Valeur 935* (F, MO, NY, US). **Prov. Santiago-Rodríguez:** between Sabaneta and Santiago de la Cruz, 24 Apr 1970, *J. Jiménez & Ariza Julia 5824* (NY); ibid., 25 Apr 1971, *J. Jiménez & Ariza Julia 5924* (FLAS, GH, UCMM, US); Cordillera Central, along rd between La Leonor and El Aguacate, 3 km W of La Leonor, 600 m, 30 May 1992, *Judd 6669* (FLAS, JBSD); Cordillera Central, El Cajuil, 10.2 km al SE de Monción, 19°21'N, 71°12'W, 600 m, 16 Jul 1985, *Mejía et al. 1408* (FLAS, JBSD, NY). **HAITI**. **Dept. de Nippes:** Massif de la Hotte, Corail, near Dutreuil, 200 m, 29 Sep 1928, *Ekman H10765* (A, S, US). **Dept. de L'Ouest:** Ile La Gonave, Lotoroué, 650 m, 28 Jul 1927, *Ekman H8722* (GH, NY, S, US); Gonave Island, near Pte. à Raquette, 1927, *Eyerdam 240* (F, GH, NY, US). **Dept. du Nord:** Massif du Nord, Acul du Nord, Morne Haut du Cap, hill at the Acul Bay, Morne Bois-Pin, 100 m, 16 Dec 1924, *Ekman H2888* (S, US). **Dept. du Nord Ouest:** vicinity of Jean Rabel, S of town, 1–13 Mar 1929, *E.C. & G.M. Leonard 13629* (GH, MO, NY, US). **UNITED STATES OF AMERICA. Florida. Miami-Dade Co.:** F.I.U. Preserve, 25°45.24'N, 80°22.57'W, 24 Apr 2005, *Adonizio 2* (FTG); off US 1 between Homestead and Naranja, 9 Jun 1973, *Almeda 1937* (USF); Long [Pine] Key, Everglades, May 1908, *Bessey 24* (MSC); ibid., *Bessey 50* (MSC); Pine Hammock Trail [Long Pine Key], Everglades National Park, 6 Jul 1965, *Bourdo s.n.* (MSC); Florida City, 16 Jul 1965, *Bourdo s.n.* (MSC); Goulds Pineland, SW 120 Ave at 224 St, 7 Jun 1998, *Bradley 1808* (FTG); Lucille Hammock Preserve, 0.8 mi W of SW 217 Ave, 0.6 mi S of 344 St, 25.438°N, 80.555°W, 5 Jul 1998, *Bradley 1908* (FTG); near Homestead, Feb 1929, *Buswell s.n.* (FTG); ibid., 8 Jul 1934, *Buswell s.n.* (FTG); Long Pine Key, 17 Jul 1937, *Buswell s.n.* (FTG); Timb's Hammock, Homestead, 5 Mar 1952, *Caldwell 8758* (FLAS, FTG, MIN); 6 mi SW of Homestead along Rt 27, 12 Mar 1956, *Churchill s.n.* (MSC); Everglades National Park, Palma Vista Hammock, SW of Homestead, 12 Oct 1962, *Cooley et al. 9201* (USF); Miami, Timbs Hammock, 26 Feb 1953, *Diaz-Piferrer 49* (HAJB); near Naranja, 27 Apr 1937, *Fennell 382* (NY); Sykes Hammock, 4 mi NW of Homestead, 27 Jan 1916, *Harris C1626* (MIN), ibid., 15 Mar 1917, *Harris C17366* (MIN); Murden Hammock, 2 mi W of Goulds, 28 Jan 1916, *Harris C1639* (MIN); ibid., 27 Apr 1923, *Harris N23226* (MIN); near Long View School, 15 Mar 1917, *Harris C17386* (MIN); Hattie Bauer Hammock, 19 Mar 1917, *Harris C17398* (MIN); Royal Palm Hammock, 14 Dec 1922, *Harris C22937* (MIN); Tim's Hammock, 27 Apr 1923, *Harris N23158* (MIN); 0.5 mi S of Naranja, 27 Apr 1923, *Harris N23257* (MIN); Royal Palm State Park, 6 Nov 1927, *Hawkins s.n.* (FLAS); Everglades National Park, E end of Long Pine Key, 25 Jul 1987, *Herndon 1760* (FLAS, FTG, NY); Everglades National Park, Long Key Campground, 80°39.28'W, 25°24.24'N, 5 Apr 1999, *Hess et al. 8560* (FLAS, NY); S of 216 St, 7.4 mi SW of jct with 194 Ave, W of Goulds, 12 Mar 1975, *Hill & Popenoe 2573* (FTG); Long Pine Key, Everglades National Park, 25 Jun 1970, *Inman 20* (FTG); Tamiami Trail to Florida Keys, Dec 1929, *Jennings s.n.* (USF); Subtropical Horticultural Research Station, Chapman Field, Coral Gables, 21 Jul 1989, *Judd 5900* (FLAS); Goulds, near jct of 248th St and 159th Ave, 17 Jul 1995, *Judd 7073* (FLAS); Girl Scout Park, Homestead, 13 Aug 1963, *Lakela 26183* (USF); Homestead, 20 Jul 1964, *Lakela 27323* (FLAS, USF); near North Homestead, 25 Jun 1968, *Lakela 31900* (USF); U.S. Coast Guard Station, 25.64°N, 80.30°W, 18 May 2001, *Lane et al. s.n.* (FTG); Castellow Hammock, 25°3.6'E × 80°5.1'E, 8 Jun 1999, *Lobo & Beck-King 031* (FTG); SE corner of SW 224 St and SW 120 Ave, Homestead, 30 Nov 1991, *Mears s.n.* (USF); SW 78 Ave & 176 St, 9 Feb 1974, *Molnar s.n.* (FTG); 1 mi W of Homestead, off Avocado Dr, Fuchs Hammock, 26 Jul 1990, *Morris 4087* (FLAS); 0.2 mi W of Tower Rd, 0.2 mi N of Lucille Dr (SW 360th St), 1.5 mi W of Florida City, Navy Wells Pineland, Royal Palm Ranger Station, 35°26'07"N, 80°30'23"W, 8 ft, 4 Sep 1999, *Orzell & Bridges 18168* (FTG, USF); near Camp Osaissa Bauer, 3 mi N of Homestead, 5 Jul 1976, *Popenoe 656* (FTG); Royal Palm State Park, 5 Mar 1944, *Rhodes s.n.* (FLAS); Everglades National Park, near Long Pine Key campground, 17 Dec 1971, *Poppleton s.n.* (USF); Castellow Hammock, Dec 1966, *Roberts 59* (FTG); Homestead, 7 Jun 1960, *Rossbach 1876* (FLAS); Homestead, 7 Mar 1908, *Sargent s.n.* (A); SW 117 Ave and Killian Dr, Miami, 17 Jun 1980, *Sauleda 3592* (USF); 2 mi N of Rt 27 on SW 217 Ave, 20 Oct 1968, *Schmal et al. s.n.* (FTG); Homestead, 7 Jun 1937, *Scull s.n.* (FLAS); near Homestead Rd, between Cutler and Longview Camp, 9–12 Nov 1903, *Small & Carter 994* (MIN, NY); ibid., *Small & Carter 1106* (NY); between Homestead and Camp Jackson, 1 Nov 1906, *Small & Carter s.n.* (MIN); Long [Pine] Key, 6–7 May 1903, *Small & Wilson 1649* (NY); near the Homestead Trail, near Camp Longview, 13–16 May 1904, *Small*

& Wilson 1696 (NY); ibid., *Small & Wilson 1932* (NY); between Homestead and Camp Jackson, 1 Nov 1906, *Small & Carter 2625* (NY); between Homestead and Cross Key, 21–22 Nov 1906, *Small & Carter 2634* (NY); Long [Pine] Key, Everglades, 18–26 Jan 1909, *Small & Carter 3060* (NY); near Goodburn Hammock, 21 Jun 1915, *Small & Mosier 6377* (NY); ibid., *Small & Mosier 6389* (NY); about Sykes Hammock, 2 Jul 1915, *Small et al. 6749* (FLAS); Everglades National Park, Dryopteris Hammock, 9 Aug 1961, *Smith 676* (USF); Everglades, 3 Jul 1971, *Sreemadhavan 4980* (USF); N of South Dade Baptist Church, Florida City, corner of 296 St and 172 Ave, 27 Jul 1990, *Tan AV7* (USF); Fire gate rd #1, Long Pine Key, Everglades National Park, *Tomlinson 21-VII-63C* (FTG); Homestead, NE 10th St, 1.5 blocks E of Krome Ave, 28 Apr 1958, *Traverse 650* (FTG); SW of Homestead, 14 May 1919, *Small & Cuthbert s.n.* (FLAS); Homestead, 10 May 1929, *Weber s.n.* (FLAS); 0.7 mi W of Eureka Rd-Old Cutler Rd jct, R40E, T56S, 21 Jun 1960, *Webster & Williams 10050* (FTG); N of Homestead, 18 Aug 1934, *Welch 1525* (NY); Everglades National Park, near jct of Anhinga Rd off Research Center Rd, 7 Jul 1984, *Whetstone 14428* (NY); between Homestead and Florida City, near FL 27, 4 Jun 1966, *Whitney 39* (USF); Redlands, Silver Palm Hammock, 23 Jun 1952, *Wilson F-9* (USF); Tamiami Pineland Complex Addition, 15 mi SW of downtown Miami, S of 12260 SW 130th St, 25.644°N, 80.393°W, 28 Apr 1999, *Woodmansee 314* (FLAS, FTG).

Miconia bicolor var. *bicolor* is the most common and widely distributed taxon of *Miconia* sect. *Miconiastrum*. It is also the most variable. Plants of the Bahamas and southern Florida are phenetically most similar to those of western Cuba (i.e., Prov. Pinar del Río), however, they consistently have mite domatia, while those of Pinar del Río are variable: some having domatia and some lacking these structures. Some plants of Pinar del Río and Isla de la Juventud have the stems, abaxial surface of their leaves, and hypanthia nearly to somewhat glabrescent and covered with a sticky secretion (e.g., *Acevedo-Rdgz. et al. 5706*, *Acuña SC-22673*, *Bécquer et al. HFC-85059*, *Killip 44741*, *Roig & Cremata SV-7117*, and *Yero D. HFC-81190*). Another group of plants have stems, abaxial surface of their leaves, and hypanthia conspicuously lepidote, and the adaxial leaf surface often drying a distinctive yellowish color (e.g., *Bécquer & Abbott HFC-82286*, *Bécquer & Morejón R. HFC-83986*, *Bécquer & Morejón R. HFC-84011*, and *Bro. León et al. LS-17821*). Variation within Pinar del Río may be ecologically correlated, but more fieldwork (and intensive molecular sampling) is required. Plants of Hispaniola are distinctive in having stems with hairs more or less globular-stellate, stellate-peltate, to dendritic and erect (see numerous specimens cited above), while stems with appressed stellate-scales or branched hairs characterize plants of other regions, except that a few specimens with erect, dendritic hairs also occur in plants of central Cuba (in the Tope de Collantes, and Pico Potrerillo regions, Prov. Sancti Spíritus; e.g., *Acevedo-Rdgz. et al. 5593*, *Ekman 13999*, *León LS-18430*). These Cuban collections also are distinctive in usually having obvious calyx lobes with evident teeth, while most populations of *M. bicolor* var. *bicolor* have lobes that are essentially obsolete and lack calyx teeth, although some plants with well-developed, or at least evident, lobes also have been collected in Pinar del Río (e.g., *Britton et al. 7116, Earle 656, Shafer 11787*). We note also that some collections from Prov. Sancti Spíritus (e.g., Loma los Helechales, *León & Clement LS-5593* and Loma la Gloria, *León & Roca LS-8003*) have well-developed calyx lobes, but stems with appressed hairs. The Hispaniolan collections, as is typical of *M. bicolor*, usually have calyx lobes that are obsolete or nearly so, but some have more or less evident lobes and teeth (e.g., *Ekman H8722, Jiménez & Ariza Julia 5824, Leonard & Leonard 13629, Valeur 935*). Some Hispaniolan specimens also have stems and young leaves with a sticky secretion (as also seen in some western Cuban plants). Most plants of central Cuba (Prov. Villa Clara, Lomas de Banao and Jatibonico in Sancti Spíritus and Cieneguitas, Cienfuegos) are distinctive in their often extremely pale to white-lepidote beneath (e.g., *Alain 4013*, *Bécquer & Veloso HFC-79904*, *Combs 128*, *Howard 5500*, *León LS-11369*, and *Smith & Hodgdon 3097*). On the other hand, material from Cumanayagua, Cienfuegos, are more or less ferrugineous beneath (and these plants also have strongly plinerved leaves; see specimens examined). Leaf shape also varies greatly within *M. bicolor* var. *bicolor*, and plants of Hispaniola tend to have leaves more similar to those of *M. angustiflora* than to those of populations of *M. bicolor* var. *bicolor* in western and central Cuba, the Bahamas, or Florida. The abaxial leaf indumentum of stellate-peltate scales, however, clearly distinguishes these Hispaniolan populations from *M. angustiflora*, which has stellate hairs abaxially.

In summary, it is clear that several poorly differentiated geographical races exist within the array of populations here considered as *M. bicolor* var. *bicolor*. These are not provided formal nomenclatural recognition because individual specimens are not always clearly diagnosable as to the entity characteristic of each geographical region. These geographically-correlated entities are 1) the populations of southern Florida and the Bahamas, 2) those of Prov. Pinar del Río and the Isla de la Juventud, Cuba (and within this region there seems to be at least

two phenetic groups, perhaps ecologically correlated), 3) those of Prov. Villa Clara, Cuba, 4) those of the Tope de Collantes and Pico Potrerillo regions, Prov. Sancti Spíritus, Cuba, 5) those from Cumanayagua, Cienfuegos, Cuba, and 6) those of the island of Hispaniola. The Tope de Collantes/Pico Potrerillo and Hispaniolan entities are the most phenetically divergent. Finally, there are a few collections of *M. bicolor* from the "Oriente" region, especially Guantánamo and Santiago de Cuba, and these require more study. *Miconia bicolor* appears to be much less common in this region than it is in central and western Cuba, and some of these specimens are difficult to distinguish from *M. barbata* or *M. maestrensis* (see discussion under these two species). More field work in these eastern provinces of Cuba is needed, along with population-level molecular study. Some specimens, e.g., *Álvarez et al. HFC-55049*, *Bécquer et al. HFC-82538*, *Bisse et al. HFC-26997*, *Bisse & Rojas HFC-3614*, *Bisse & Köhler HFC-7412*, are tentatively treated within *M. bicolor*, while others, e.g., *Bros. León & Alain LS-19256*, *Michelangeli et al. 1559*, *Shafer 2975* and *Shafer 3765*, although somewhat similar, are considered within *M. barbata* (because of the form of their hairs). We note that *M. barbata* and *M. maestrensis* have stellate hairs (not the stellate-peltate scales of *M. bicolor*) on their adaxial leaf surfaces (see key for other differentiating characters).

It is obvious that *Miconia bicolor* is most diverse on the island of Cuba, and it is noteworthy that var. *patenti-setosa* is endemic to Cuba. We hypothesize that the species originated on this island, only later dispersing to Hispaniola, the Bahamas, and southern Florida.

Miconia bicolor was first reported from the United States by J.K. Small (1905) based on populations collected in pinelands (*Pinus elliottii* Engelm.) of Miami-Dade county. The species is restricted to this county, and is most characteristic of pinelands on Miami oölitic limestone. These pinelands largely have been destroyed by agriculture and urban growth (Myers & Ewel 1990) and the species thus is considered threatened by the state of Florida (Weaver & Anderson 2010). *Miconia bicolor* is occasionally used as an ornamental (Meerow 1991; Osorio 1991; Haynes et al. 2001;). Beautiful illustrations have been published by de la Sagra (1850), Sargent & Faxon (1911), Correll & Correll (1982), and Wurdack & Kral (1982).

2b. Miconia bicolor (Mill.) Triana var. **patenti-setosa** (Borhidi) Judd, Bécquer, & Majure, comb. nov. *Tetrazygia bicolor* (Mill.) Cogn. var. *patenti-setosa* Borhidi, Acta Bot. Acad. Sci. Hung. 23:39. 1977 [1978]. TYPE: CUBA. PROV. PINAR DEL RÍO: Cerro de Cabras, 10 Oct 1954, fr, *Acuña & Torres 19461* (HOLOTYPE: HAC!; ISOTYPE: HAC!, HAJB!).

Stems and inflorescence axes with scattered, elongate, multicellular, eglandular hairs.

Phenology.—The taxon has been collected in fruit only in October.

Distribution.—*Miconia bicolor* var. *patenti-setosa* is only known from Cuba, Prov. Pinar del Río, in the Cerro de Cabras.

Miconia bicolor var. *patenti-setosa* is known only from the type; additional collections are needed, and the taxon is here only provisionally recognized. It is of interest that no other taxon of *Miconia* sect. *Miconiastrum* has elongate, multicellular hairs on the stems; such hairs are only known from mite domatia.

3. Miconia guajaibonensis Judd, Bécquer, & Majure, nom. nov. (**Fig. 3C, D**). *Tetrazygia lanceolata* Urb., Repert. Spec. Nov. Regni Veg. 22:223. 1926, non *M. lanceolata* DC., Prodr. 3:190. 1828. TYPE: CUBA. Prov. Pinar del Río: Pan de Guajaibón, on the very top of the mountain, 750–800 m, 9 Jan 1921, fl, *E.L. Ekman 12767* (LECTOTYPE: S!, here designated, because holotype at B destroyed; ISOLECTOTYPE: NY!, fragment).

Evergreen **shrub** up to 4.5 m. Young **stems** terete to slightly quadrangular, the indumentum of dense, multicellular, ferrugineous, matted to erect, dendritic to globular stellate hairs or appressed stellate-peltate scales, becoming ± glabrate with age, without elongate, multicellular, non-glandular hairs, internodes 0.5–1.8 cm long, lacking longitudinal ridges, nodal line present, faint. **Leaves** isophyllous or nearly so; petiole 0.7–2.5 cm long, the indumentum of dense, ± matted, stellate-peltate scales to stellate-peltate scales, partially deciduous with age; the blade 3–8.6(–9.3) × 0.7–2.4(–3.3) cm, ovate, usually falcate, chartaceous, the apex acuminate to attenuate, the base obtuse to rounded, the margin plane to slightly revolute, entire; secondary veins two pairs, one pair conspicuous and one pair inconspicuous, acrodromous, basal, the innermost pair joining midvein at base to 1 mm above the leaf base, the conspicuous secondary veins placed 0.8–3.5 mm in from margin, the inconspicuous secondary veins intramarginal, tertiary veins percurrent, oriented subperpendicular to midvein,

0.7–4 mm apart, quaternary veins obscure to visible, ± reticulate, not connecting adjacent tertiary veins or with 1–3 quaternaries connecting adjacent tertiary veins, the higher order veins reticulate; the midvein and major secondary veins slightly impressed to flat, tertiary and higher order veins flat on adaxial surface, the midvein moderately to strongly raised, the major secondary veins flat to moderately raised, the minor secondary veins and tertiary veins flat, and the higher order veins flat on the abaxial surface; adaxial surface appearing smooth to slightly wrinkled after drying, with scattered to abundant druse crystals, and drying darker than the abaxial surface, the indumentum initially of dense, pale ferrugineous, stellate-peltate scales, but very quickly glabrescent, although a few scales often retained on midvein proximally; abaxial surface pale green but pale ferrugineous due to dense covering of stellate-scales, the epidermal surface ± smooth, with dense, appressed, ferrugineous or pale ferrugineous, stellate-peltate scales, 0.09–0.17 mm across, the veins with similar scales, but sometimes more irregular in form, such hairs on lamina and veins ± persistent; mite domatia present or absent, at junction of midvein and major secondary veins, consisting of dense cluster of multicellular, elongate, pale ferrugineous to red, barbate, eglandular hairs, 0.5–1 mm long. **Inflorescences** terminal, paniculate cymes, 3.5–9 cm long, 2.5–6.5 cm across, with 2–4 major branch pairs, the peduncle 1.7–3.8 cm long, the ultimate axes (pseudopedicels) 1–5.5 mm long, and numerous flowers well separated from each other; bracts 0.7–1 × 0.2–0.4 mm, but probably also larger, ± triangular or narrowly so, with acute to obtuse apex, early deciduous; bracteoles 0.4–0.7 × 0.1–0.2 mm, narrowly triangular, with acute apex, ± deciduous. **Flowers** 5-merous, zygomorphic (due to positioning of the stamens), with pedicel 1.3–3 mm long. **Hypanthium** 4.5–6 mm long, terete and ± slightly constricted above ovary, the free portion 1.8–3.3 mm long, 2.2–2.8 mm wide at the torus, the outer surface with moderate to dense, stellate-peltate scales, the internal surface smooth, glabrous. **Calyx** lobes 5, separate (and imbricate) in bud, the tube 1–1.7 mm long, irregularly tearing between lobes, with moderate to dense stellate-peltate scales abaxially, and moderate to dense stellate-peltate to globular stellate hairs adaxially, the lobes unequal, usually the 2 outer lobes larger than the rest, 0.45–1.2 × 1–2.4 mm, triangular to shortly triangular, the apex rounded to obtuse, with hairs similar to those of the tube, green, often red-tinged; calyx teeth present, ± 0.1 mm long, merely a dorsal, slightly ellipsoidal bump, with rounded apex, and hairs similar to those of calyx. **Petals** 5, 4.5–6.3 × 2.5–4 mm, obovate, spreading, white, glabrous but both surfaces densely papillose-granulate, the apex rounded and asymmetrically notched, the base slightly narrowed to a broad attachment, the margin entire. **Stamens** 10, isomorphic, ± geniculate near filament apex; staminal filament 4.5–5.5 mm long, glabrous, pale yellow, anther thecae 5–5.8 × 0.6–0.8 mm, subulate, straight to slightly incurved, opening by a small dorso-apical pore, yellow, the connective not prolonged below the thecae, glabrous, but the filament emerging from slight depression in sterile, minutely dorso-lobed anther base. **Ovary** 3-locular, ca. 4/5-inferior, 3.4–3.7 mm long, 1.4–2 in diameter, oblong to ellipsoid, apically conic, unridged, glabrous, the apex with a short, slightly ridged collar but lacking a crown, with axile placentation, the ovules numerous, borne on a small placenta not extending or only slightly extending into locule; style 10–13 mm long, distally curved, white, glabrous; stigma punctate, minutely papillose, 0.15–0.2 mm wide. **Berries** 5–8 mm long, 4.3–6.5 mm in diameter (excluding persistent hypanthium and calyx tube), globose to ellipsoid, purple-black, with scattered stellate-peltate scales, the hypanthium constricted, 1.3–1.7 mm wide at narrowest point and 2–3 mm wide at torus, but appearing strongly constricted due to flaring calyx tube. **Seeds** 1.1–1.6 mm long, angular-obovoid, with ± rectangular raphe, the testa ± smooth; appendage absent.

Phenology.—Recorded in flower in January, March, May and November.

Distribution and habitat.—*Miconia guajaibonensis* is endemic to Pan de Guajaibón, in Pinar del Río, Cuba (Fig. 5), from 680–800 m, in thickets over limestone.

Additional specimens examined: **CUBA. Prov. Pinar del Río:** Pan de Guajaibón, la Mulata, 16 May 1953, *Acuña & Bro Alain SV-18519* (HAC); en la cumber del Pan de Guajaibón, 750 m, 2 May 1959, *Bro. Alain 6778* (HAC); Bahia Honda, Pan de Guajaibón, ladera N, cerca de la cima, 680–700 m, 30 Mar 2004, *Bécquer HFC-81700* (HAJB); cima del Pan de Guajaibón, 700 m, Jul 2005, *Bécquer & Abbott HFC-82431* (FLAS, HAJB); La Palma, cima del Pan de Guajaibón, 720 m, 28 Dec 1970, *Bisse HFC-15640* (HAJB); Consolación del Norte, Pan de Guajaibón, 14 Oct 1976, *Bisse et al. HFC-32501* (HAJB); segunda mitad del Pan de Guajaibón, 14 Apr 1980, *Herrera et al. SV-29487* (HAC); ibid., *Herrera et al. SV-29488* (HAC); Guajaibón, 4 Nov 1860–1864 [probably 1862], *Wright 1222 p.p.* (CAS on-line image, GH, MO, P on-line image, S).

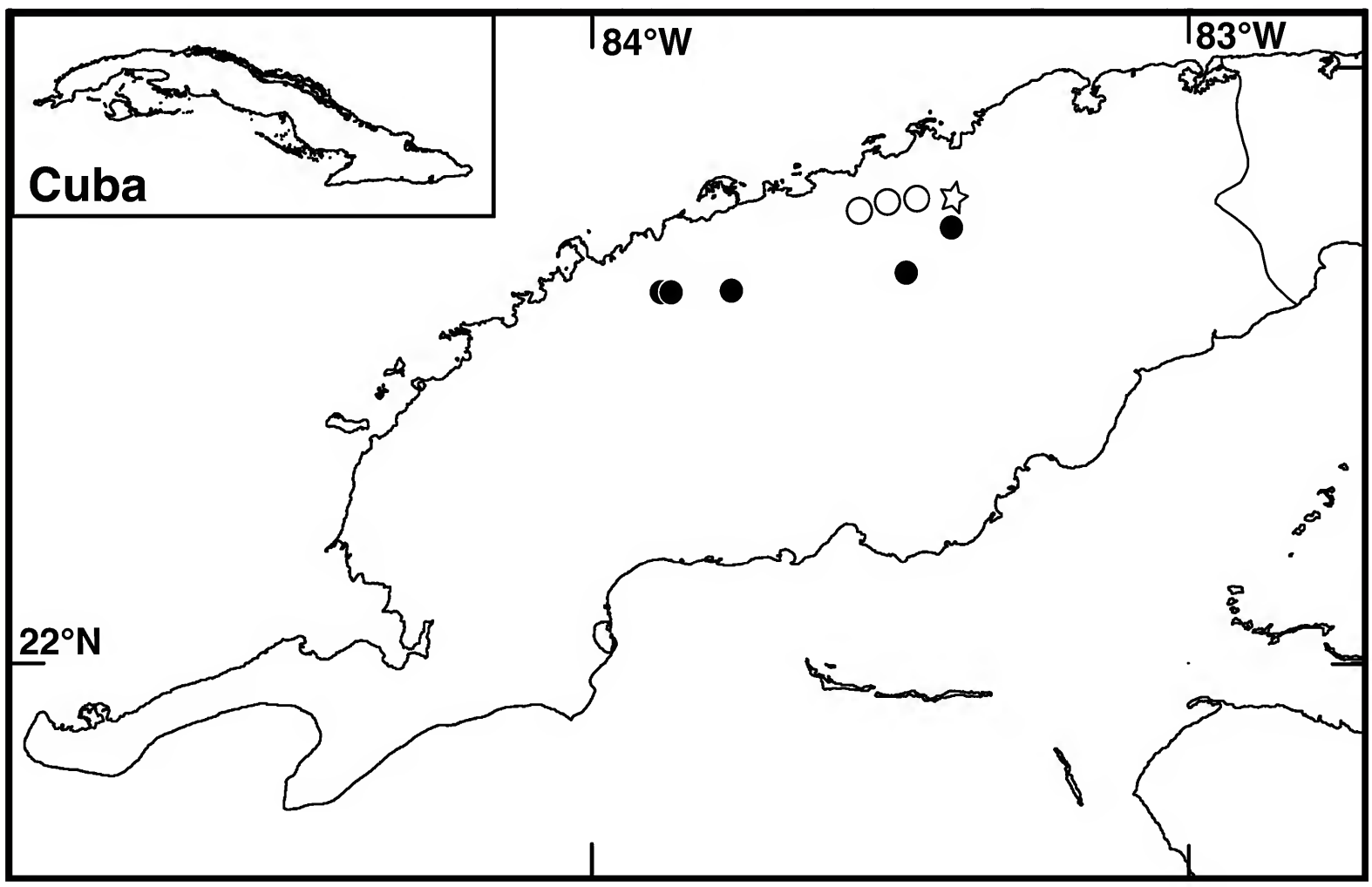


Fig. 5. Distribution of *Miconia guajaibonensis* (star), *M. impressa* (closed circles), and *M. cajalbanensis* (open circles) in western Cuba.

Few collections of this rare and geographically restricted species are known, and *Miconia guajaibonensis* is morphologically quite uniform, although it seems to vary in the development of mite domatia, as in the western Cuban populations of *Miconia bicolor*. These two species likely are closely related, as both are characterized by an indumentum of stellate-peltate scales on the abaxial leaf surface; see key for their differentiating characteristics.

The new name, *Miconia quajaibonensis*, is needed because the epithet "lanceolata" is occupied in *Miconia*, i.e., *M. lanceolata* DC. The new epithet highlights the only known locality at which this rare (and possibly endangered) species occurs. Currently, six species, including *M. guajaibonensis*, are known to be endemic to Pan de Guajaibón (Borhidi & Muñoz 1985; Borhidi 1991; Judd et al. 2008; Morejón & Sanchez 2012).

4. Miconia impressa (Urb.) Judd, Bécquer, & Majure, comb. nov. (**Fig. 3E**). *Tetrazygia impressa* Urb., Repert. Spec. Nov. Regni Veg. 22:225. 1926. Type: CUBA. Prov. Pinar del Río: Sierra de los Órganos, Grupo del Rosario, Sierra de Pendejeral, on top of the ridge, 14 Sep 1923, fl, fr, *E.L. Ekman 17539* (lectotype: S!, here designated, because specimen at B destroyed; isolectotype: NY!, fragment).

Tetrazygia versicolor Urb., Repert. Spec. Nov. Regni Veg. 22:224. 1926. Type: CUBA. Prov. Pinar del Río: Sierra del Sitio Santo Tomás, steep limestone cliffs, 500 m, 10 Jun 1923, fl, *E.L. Ekman 16625* (lectotype: S!, here designated, because specimen at B destroyed; isolectotype: US, on-line image #00120756!).

Tetrazygia minor Urb., Repert. Spec. Nov. Regni Veg. 22:224. 1926. *Tetrazygia lanceolata* Urb. subsp. *minor* (Urb.) Borhidi, Acta Bot. Acad. Sci. Hung. 23:79. 1977 [1978]. Type: CUBA. Prov. Pinar del Río: San Diego de los Baños, at the foot of Sierra de la Guira, 24 Oct 1923, sterile, *E.L. Ekman 17785* (lectotype: S on-line image #05-3527!, here designated, because specimen at B destroyed; isolectotype: NY!, fragment, on-line image #00099743).

Evergreen **shrub** up to ca. 3 m. Young **stems** terete to slightly quadrangular, the indumentum of dense, matted, pale ferrugineous, stellate to dendritic hairs, becoming only sparse with age, without elongate, multicellular, non-glandular hairs, internodes 0.5–4.2 cm long, lacking longitudinal ridges, nodal line absent or present, faint. **Leaves** isophyllous or nearly so; petiole 0.7–3.7 cm long, the indumentum of dense, stellate to dendritic

hairs; the blade 2.1–9.7 × 0.8–3.6 cm, ovate to elliptic, not falcate, chartaceous to thinly coriaceous, the apex acute to acuminate, the base obtuse to rounded or slightly cordate, the margin plane to slightly revolute, entire; secondary veins in two pairs, one pair conspicuous and one pair inconspicuous, acrodromous, basal, the innermost pair joining midvein at base to 1.5 mm above the leaf base, the conspicuous secondary veins placed 1.3–6 mm in from margin, the inconspicuous secondary veins intramarginal to 1 mm in from margin, tertiary veins percurrent, oriented subperpendicular to midvein, 1–5.5 mm apart, connected by a single quaternary vein, or quaternary veins reticulate, not connecting tertiary veins, the higher order veins reticulate, the midvein and major secondary veins moderately to slightly impressed (occasionally flat), tertiary veins slightly impressed to flat, remaining veins flat on adaxial surface; the midvein strongly raised, the major secondary veins moderately to slightly raised, the minor secondary veins and tertiary veins slightly raised to flat, and the higher order veins flat on abaxial surface; adaxial surface appearing slightly wrinkled after drying, with scattered druse crystals, and drying darker than the abaxial surface, the indumentum initially of dense, white to very pale ferrugineous, globular stellate to stellate hairs, but very quickly glabrescent, although sometimes a few hairs remaining on proximal portion of midvein; abaxial surface pale green, the surface smooth to very slightly bullate, with ± dense, white to very pale ferrugineous, stellate hairs, usually 0.12–0.24 mm across, the veins with dense, similar hairs, such hairs on lamina and veins persistent to rarely somewhat deciduous; mite domatia usually present at junction of midvein and major secondary veins, at least on some leaves of each shoot, but sometimes such domatia absent, when present well to poorly developed, composed of elongate, multicellular, eglandular, pale yellow to ferrugineous, barbate hairs, 0.2–1 mm long. **Inflorescences** terminal, paniculate cymes, 4–8.5 cm long, 2.5–4.5 cm across, with 2–4 major branch pairs, the peduncle 1–5 cm long, the ultimate axes (pseudopedicels) 1–4 mm long, and the numerous flowers well separated from each other; bracts quickly deciduous, not seen, probably ± triangular; bracteoles 0.5–1.2 × 0.15–0.2 mm, narrowly triangular, with acute apex, deciduous. **Flowers** 5-merous, zygomorphic (due to positioning of the stamens), with pedicel 0.5–1.5 mm long. **Hypanthium** 5–6 mm long, terete and not to only slightly constricted above ovary, the free portion 2.5–2.7 mm long, 1.5–2.5 mm wide at the torus, the outer surface with ± dense stellate hairs, the internal surface smooth to very slightly longitudinally ridged, glabrous. **Calyx** lobes 5, fused in bud as a conical calyptra, but with a minute, apical opening, the tube 1.4–1.6 mm long, consistently and usually regularly tearing, with calyptra-like remnants consisting of 2 or 3 lobes, occasionally tearing more regularly between lobes, and at anthesis the tube thus appearing only ca. 0.5 mm long, with moderate to dense stellate hairs abaxially, and sparse to moderate branched to stellate hairs adaxially, the lobes 0.3–0.6 × 0.15–0.5 mm, ± triangular (but actual calyx lobes not evident at anthesis, appearing as a small apiculum at apex of torn, irregular to ± triangular pseudo-lobes), the apex acute, with hairs similar to those of the tube, green; calyx teeth present, 0.1–0.2 mm long, represented merely by an ellipsoidal bump, nearly filling each of the reduced calyx lobes, green, with rounded apex, and hairs similar to those of calyx. **Petals** 5, 4.5–6 × ca. 3.5–4.2 mm [but possibly larger, as values based on slightly immature flower and original description], asymmetrically obovate, spreading to reflexed, white, glabrous but both surfaces densely papillose-granulate, the apex rounded, slightly notched, the base slightly narrowed to a broad attachment, the margin entire. **Stamens** 10, isomorphic, ± geniculate near filament apex; staminal filament 3.5–6 mm long [measurements based on slightly immature flower and original description], glabrous, white, anther thecae 4.5–6 × 0.8–1 mm, subulate, straight to slightly incurved, opening by a small dorso-apical pore, yellow, the connective not prolonged below the thecae, glabrous, but the filament emerging from slight depression in sterile, minutely dorso-lobed anther base. **Ovary** 3-locular, ca. 3/4 inferior, ± ellipsoid, 2–4.5 mm long, 1.5–2.5 mm in diameter, apically cylindric-conic, glabrous, the apex with small slightly ridged collar but lacking crown, with axile placentation, the ovules numerous, borne on a small placenta that extends only slightly into locule; style 9–11 mm long, nearly straight to distally curved, white to pink, glabrous; stigma punctate, minutely papillose, ca. 0.15 mm wide. **Berries** 4–8.5 mm long, not including the persistent hypanthium and calyx, 3.5–7 mm in diameter, globose, subglobose, or ellipsoid, purple-black, with scattered stellate hairs, the hypanthium constricted, 1.3–2.5 mm wide at narrowest point and 1.7–3.5 mm wide at torus, but appearing strongly constricted due to expanded calyx tube. **Seeds** 1–1.7 mm long, angular-obovoid, with ± rectangular raphe, the testa ± smooth; appendage absent.

Phenology.—Collected in flower in June, July and September.

Distribution and habitat.—*Miconia impressa* is endemic to Pinar del Río, in western Cuba (Fig. 5), occurring from 500–614 m in thickets over limestone.

Additional specimens examined. **CUBA. Prov. Pinar del Río:** Viñales, cresta del mogote al O del sendero Coco Solo-Palmarito, 22°37.409N, 83°43.282W, 377 m, 21 Jul 2013, *Barrios et al.* (HAJB); Baños San Vicente, rocky limestone hill, 12–16 Sep 1910, *N.L. Britton et al. 7464* (NY, US); sierra Sitio del Infierno, base S, ascenso y cima del mogote de El Americano, cumber más alta, 614 m, 22 Jul 1991, *Sánchez HFC-69824* (HAJB); mogote de Dos Hermanas, Viñales, 7 Oct 1989, *Urquiola et al. HPR-5629* (HAJB, HPPR); cima de la Sierra del Infierno, Viñales, 4 Jul 1990, *Urquiola et al. HPR-6004* (HAJB, HPPR); without definite locality, *Wright s.n.* (GH, NY).

Miconia impressa is distinctive, and separable from other species of the *M. bicolor* complex, because of its flower buds that have a nearly closed (apically), conical calyptra (formed from the calyx tube), so the petals are hidden in bud (although minute, free calyx lobes are still present at the apex of the calyptra). As the flowers mature, the calyx tube usually tears completely and irregularly as a calyptra (of one or two pieces, each formed by fused lobes) or occasionally into more or less regular "lobes," allowing the petals and stamens to emerge. It is also distinctive in having leaves with a dense, abaxial indumentum of more or less white, stellate hairs (see key). The species is somewhat variable in leaf size, the impression of the veins adaxially, and in the presence, and prominence of mite domatia. Thus, *Tetrazygia versicolor* and *T. minor* are here considered within the circumscription of *M. impressa*.

5. Miconia barbata (Borhidi) Judd, Bécquer, & Majure, comb. nov. (**Fig. 6A**). *Tetrazygia barbata* Borhidi, Acta. Bot. Acad. Sci. Hung. 23:38. 1977 [1978]. TYPE: CUBA. Prov. Oriente [Holguín]: Playa de Moa, 25 Jul 1941, *Bro. León LS-20286, with Bro. Clemente, & R. Howard* (HOLOTYPE: HAC!; ISOTYPES: NY!, HAC!).

Evergreen **shrub** or tree to 5.5 m. Young **stems** terete to slightly quadrangular, the indumentum of dense, brunnescent to pale ferrugineous, stellate, globular-stellate to dendritic hairs, without elongate, multicellular, non-glandular hairs, internodes 0.7–8 cm long, lacking longitudinal ridges, nodal line present, faint. **Leaves** isophyllous or nearly so; petiole 1.6–3 cm long, the indumentum of brunnescent to ± ferrugineous, globular-stellate to stellate hairs to stellate-peltate scales with ± free arms; the blade 4.5–19 × 1.6–5.6 cm, ovate to elliptic or oblong, ± falcate, chartaceous to thinly coriaceous, the apex acuminate to attenuate, the base obtuse to rounded, the margin plane to slightly revolute, entire to slightly undulate; secondary veins 2 pairs, one pair conspicuous and one pair inconspicuous, acrodromous, basal, the innermost pair joining midvein at base to 4 mm above the leaf base, the conspicuous secondary veins placed 1.7–11 mm in from margin, the inconspicuous secondary veins intramarginal to 2.3 mm in from margin, tertiary veins percurrent, oriented subperpendicular to midvein, 1.5–9 mm apart, connected by 1 or 2 quaternary veins, or such veins ± reticulate and not connecting the tertiaries, the higher order veins reticulate, the midvein and major secondary veins slightly impressed, tertiary veins slightly impressed to flat, remaining veins flat on adaxial surface; the midvein strongly raised, the major secondary veins moderately to slightly raised, the minor secondary veins and tertiary veins slightly raised to flat, and the higher order veins flat on abaxial surface; adaxial surface appearing slightly wrinkled after drying, with scattered druse crystals, and drying darker than the abaxial surface, the indumentum initially of ± dense, brunnescent to pale ferrugineous, globular-stellate hairs and stellate-peltate scales with ± free arms, but very quickly glabrescent, although sometimes a few hairs persistent on proximal portion of midvein; abaxial surface pale green but ± brunnescent due to indumentum, the surface smooth to bullate, with moderate to dense, brunnescent to pale ferrugineous, globular-stellate hairs and stellate-peltate scales with ± free arms, 0.13–0.24 mm across, the veins with similar hairs, such hairs on lamina persistent to partly deciduous and those on the veins also persistent to deciduous, especially on midvein and major secondary veins, but occasionally also on tertiary veins; mite domatia well-developed (i.e., to 11 mm in length), consistently present, at junction of midvein and major secondary veins, sometimes also at junction of midvein and tertiary veins, and formed by tuft or ± dense mass of elongate, barbate, pale yellow to ferrugineous, eglandular hairs, from 0.2–1.7 mm long. **Inflorescences** terminal, paniculate cymes, 6–16 cm long, 3.5–11 cm across, with 3–5 major branch pairs, the peduncle 1.4–5 cm long, the ultimate axes (pseudopedicels) 1–4.5 mm long, and the numerous flowers well separated from each other; bracts 0.5–1 × 0.2–0.3 mm, but probably also larger,

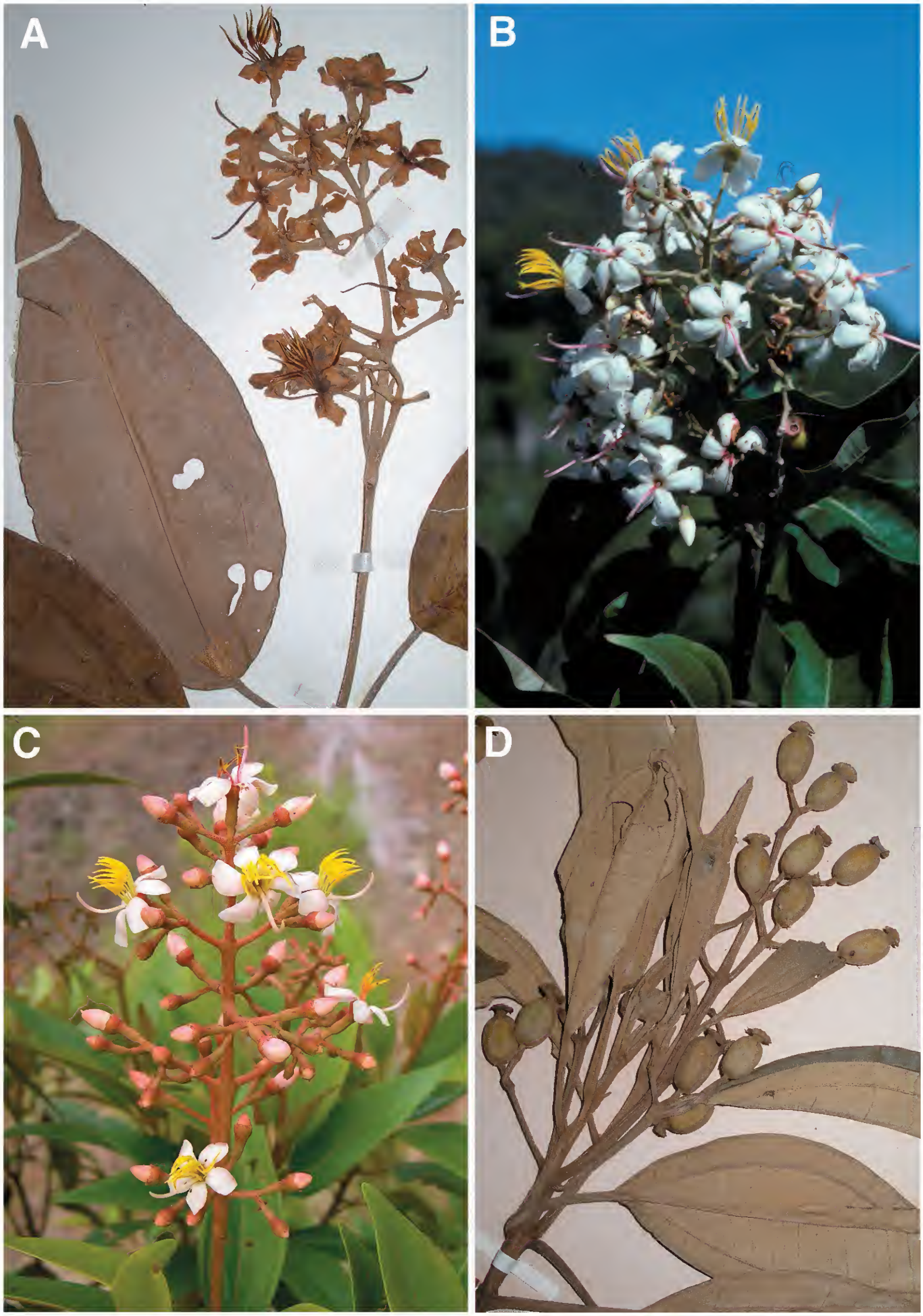


Fig. 6. **A.** *Miconia barbata* (*Ekman 9484*). **B.** *M. angustiflora* (*Judd 5302*). **C.** *M. cajalbanensis* (*Bécquer & Abbott 82423*). **D.** *M. maestrensis (Ekman 14920).*

narrowly triangular to triangular, the apex acute, quickly deciduous; bracteoles 0.3–0.5 × 0.1–0.3 mm, narrowly triangular to triangular, with acute apex, deciduous. **Flowers** 5- or occasionally 6-merous, zygomorphic (due to positioning of the stamens), with pedicel 1–2.5 mm long. **Hypanthium** 4.5–7.5 mm long, terete and slightly constricted above ovary, the free portion 2.5–4 mm long, 2–2.7 mm wide at the torus, the outer surface with moderate to dense stellate hairs, the internal surface smooth to very slightly longitudinally ridged, glabrous. **Calyx** lobes 5 (6), separate in bud, the tube 0.8–2.3 mm long, usually not tearing between lobes, with moderate to dense stellate hairs abaxially, with moderate to dense branched to stellate hairs adaxially, the lobes 0.3–1.5 × 1.5–3 mm, triangular to broadly triangular, the apex acute to obtuse or rounded, with hairs similar to those of the tube, green, sometimes red-tinged; calyx teeth present, 0.1–0.15 mm long, merely a small bump near apex of lobe, green, with rounded apex, and hairs similar to those of calyx. **Petals** 5 (6), 6–8.5 × 3.5–5.5 mm, asymmetrically obovate, spreading, white (but pink-tinged with age), glabrous but both surfaces densely papillose-granulate, the apex ± rounded, sometimes obscurely notched, the base slightly narrowed to a broad attachment, the margin entire. **Stamens** 10 (12), isomorphic, ± geniculate near filament apex; staminal filament 5.3–7 mm long, glabrous, pale yellow, anther thecae 5–7.7 × 0.9–1.2 mm, subulate, straight to slightly incurved, opening by a small dorso-apical pore, yellow, the connective not prolonged below the thecae, glabrous, but the filament emerging from slight depression in sterile, minutely dorso-lobed anther base. **Ovary** 3-locular, ca. 3/4 inferior, ellipsoid to ± oblong, apically conical, glabrous, the apex with a small, slightly ridged collar but lacking a crown, with axile placentation, the ovules numerous, borne on small placenta not or only slightly extending into locule; style 10–15 mm long, distally curved, white (but pink-tinged with age), glabrous; stigma punctate, minutely papillose, ca. 0.15 mm wide. **Berries** 6–13 mm long, 4–10 mm in diameter, ellipsoid to nearly globose, purple-black, with scattered, stellate hairs, the hypanthium constricted, 1.5–2.5 mm wide at narrowest point and 2–3 mm wide at torus, but appearing strongly constricted due to flaring calyx tube. **Seeds** 1–2 mm long, angular-obovoid, with ± rectangular raphe, the testa slightly to distinctly roughened due to bulging cells, except on distal surface where ± smooth, the raphe also smooth; appendage absent.

Phenology.—Recording in flower in March (and likely also April), July, August, October, and December, and probably flowering year around.

Distribution and habitat.—*Miconia barbata* is restricted to the central and northern "Oriente" region, mainly in Prov. Guantánamo and Holguín, Cuba, occurring in the Sierra de Nipe, mountains near Bayate, Monte Verde, and in the vicinity of Moa and Baracoa (Fig. 7), from near sea-level to 745 m, in pinelands, thickets, forests along arroyos, and semideciduous forests on limestone.

Additional specimens examined: **CUBA. Prov. Guantánamo:** prope Bayate, Sabana Miranda, 11 July 1914, *Ekman 1946* (NY, S) Bayate, Cayo del Rey, 21 Feb 1915, *Ekman 4694* (S); Charrascal de la Cuaba, Baracoa, 12 Apr 1969, *L. Figueiras UO-778* (HAJB); Baracoa, Taco Bay, camino de Yamanigüey, 12 Apr 1960, *L. Figueiras UO-778* (HAC); ibid., 24 Jul 1969, *L. Figueiras UO-2166* (HAC, HAJB); Baracoa, Camino Alto La torre, Nibujón, SE de Taco Bay, 20° 30'1.8" N, 74° 39'43.2" W, 150 m, 23 Oct 2009, *Michelangeli et al. 1504* (FLAS); Monte Verde, La Perla, 4 May, 2 Jul,1859–1864, *Wright 1222 p.p.* (CAS on-line image, MO, P on-line image). **Prov. Holguín:** Sierra de Nipe, loma al S de la Unidad Silvícola Forestal "Pinal Redondo," cerca del arroyo La Chivera, 480 m, 25 Apr 2004, *Bécquer HFC-82254* (FLAS, HAJB); Moa, Río Quesigua, donde cruza la carretera de Moa-Baracoa, 5–10 m, 27 Mar 2009, *Bécquer et al. HFC-85468* (HAJB); Sierra de Nipe, orillas del río Piloto, cerca de las cabezadas, Apr 1968, *Bisse & Köhler HFC-8529* (HAJB); Cuevas de Purnio, 5 Nov 1971, *Bisse et al. HFC-20767* (HAJB); Moa, Los Farallones de Moa, 300 m, 31 Mar 1972, *Bisse & Berazaín HFC-22229* (HAJB); Mayarí Abajo, Sierra de Nipe, orillas de arroyos en el camino a Woodfred, 600 m, 2 Jun 1979, *Bisse et al. HFC-36020* (HAJB); Moa, Monte la Breña alrededores del campamento Los Carboneros camino hacia el río Yagrumaje, 300 m, 17 Apr 1981, *Bisse et al. HFC-44469* (HAJB); Mayarí, Pinares de Mayarí, cerca del campamento de pineros en el valle superior del río Piloto, 400 m, 31 May 1983, *Bisse et al. HFC-50610* (HAJB); Moa, Cerro de la Embocadura del río Yamanigüey, 24 Mar 1970, *Borhidi et al. SV-27946* (HAC); ibid., *Borhidi et al. SV-27947* (HAC); Moa, Dec 1939, *Mrs. Bucher 144* (HAC, NY); Moa, *Bucher SV-11442* (HAC); Sierra de Nipe, El Taller (ad Río Piloto), 21 Jul 1914, *Ekman 2089* (S, US); Sierra de Nipe, ad Río Piloto, 5 Oct 1919, *Ekman 9684* (NY, S, US); Pinares de Mayarí, Sierra de Nipe, 27–31 May 1960, *L. Figueiras UO-952* (HAC, HAJB); Moa, camino a mina Mercedita, 16 Mar 2000, *Fritsch et al. SV-41362* (HAC); 5 km S of Woodfred, Sierra de Nipe, Jul 1941, *Howard 6149* (GH, MO, NY); Moa, 30 Jul or 3 Aug 1945, *Bro. León et al. LS-22506* (GH, HAC, HAJB); Charrasco de la Cueva, Sierra de Nipe, 700 m, 27 Jul 1940, *Bros. León & Alain 19256* (NY); Moa, Charrascal 1.5 km al E de Yamanigüey, carretera Moa-Baracoa, 20°34'22.8"N, 74°44'46.2"W, 10 m, 26 Oct 2009, *Michelangeli et al. 1539* (FLAS, HAJB, NY); Mayarí, via Cayo Mujeres, 3 km al N y luego 1 km al O por la carretera desde el Hotel Pinares de Mayarí, 20°31'39.6"N, 75°45'34.8"W, 745 m, *Michelangeli et al. 1559* (FLAS, HAJB, NY); crest of Sierra Nipe, 600–700 m, 16–17 Oct 1941, *Morton & Acuna 3044* (DUKE, F, FLAS, FTG, MO, NY, US); Sierra Nipe, near Woodfred, 500–650 m, 4 Dec 1909, *Shafer 2975* (NY); near base of Loma Mensura, 680 m, 1–3 Feb 1910, *Shafer 3765* (NY, US).

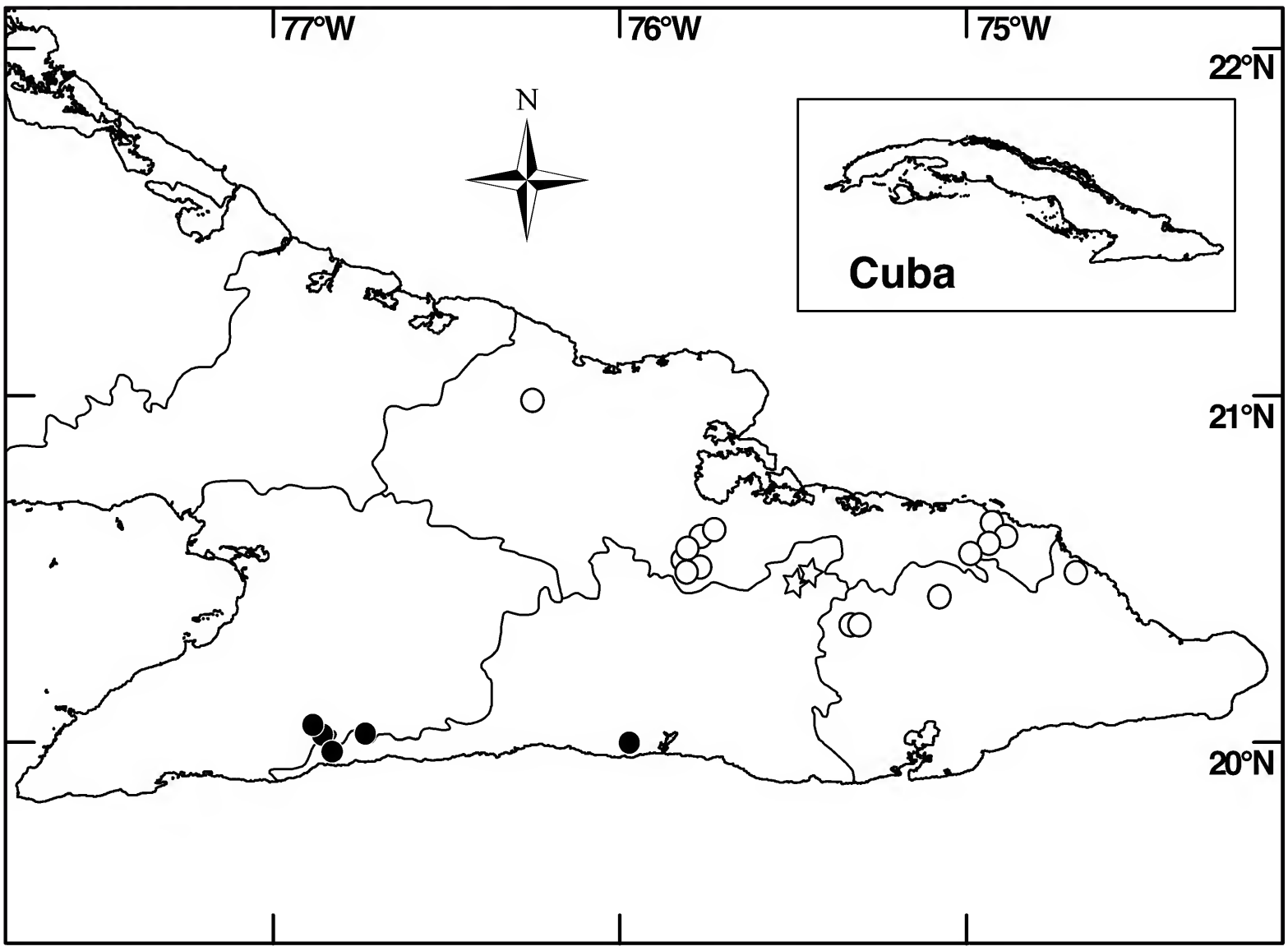


Fig. 7. Distribution of *Miconia barbata* (open circles), *M. cristalensis* (stars), and *M. maestrensis* (closed circles) in eastern Cuba.

Miconia barbata shows some geographically correlated variation, with plants of the Sierra de Neiba often having a denser abaxial leaf indumentum than those of other regions; additionally, the plants of the Moa region have abaxial epidermal cells that are more clearly bullate (and their abaxial epidermis is clearly visible, because many of the stellate hairs are deciduous on older leaves).

The species often has been confused with *Miconia bicolor* (see specimen annotations) even though it is readily distinguished by the indumentum of the abaxial leaf surface, i.e., with stellate hairs or stellate-peltate scales with largely free arms in *M. barbata* and with stellate-peltate scales (i.e., the arms usually strongly fused) in *M. bicolor* (see also Borhidi, 1978, who described the indumentum of *M. barbata* as radiate scales). Abaxial mite domatia are consistently present in *M. barbata* (although they range from prominent to occasionally more or less inconspicuous), while they may or may not occur in *M. bicolor.* The two species are partly geographically isolated (Figs. 4, 7) but likely co-occur (more field work is needed in the "Oriente" region). *Miconia barbata* is actually much more difficult to distinguish from *M. angustiflora*, a Jamaican endemic, which has less well developed mite domatia (and frequently entirely lacks such domatia; see key).

6. Miconia angustiflora (Benth.) Naudin, Ann. Sci. Nat. Bot. sér. 3, 16:246. 1850. (**Fig. 6B**). *Diplochita angustiflora* Benth., Pl. Hartw. 263. 1846. *Tetrazygia angustiflora* (Benth.) Griseb., Goett. Abh. 9:53. 1861. Type: JAMAICA: Stony Hill (not seen).

Tetrazygia ovata Cogn., Symb. Antill. 5(3):447. 1908. Type: JAMAICA. [St. Catherine Parish]: Holly Mount, prope Ewarton, 867 m, 2600 ft, 11 Aug 1896, fl, *W. Harris 6450* (holotype: B, destroyed; isotypes: F!, NY!, 2 sheets, on-line images #00099744 and 00099745!).

Evergreen **shrub or tree** to 10 (–15) m. Young **stems** terete to slightly quadrangular, the indumentum of dense, ferrugineous to pale ferrugineous, stellate to globular-stellate hairs, without elongate, multicellular, non-glandular hairs, internodes 0.5–11.3 cm long, lacking longitudinal ridges, nodal line present, faint. **Leaves** isophyl-

lous or nearly so; petiole 1.3–6.6 cm long, the indumentum of dense to moderate, stellate hairs; the blade 5.3–20 × 1.8–8.3 cm, ovate to elliptic or obovate, falcate or not, coriaceous, the apex acuminate to attenuate, the base narrowly cuneate or acute to obtuse or rounded, the margin plane to slightly revolute, entire to slightly undulate; secondary veins 2 pairs, one pair conspicuous and one pair inconspicuous, acrodromous, basal, the innermost pair joining midvein at base to 10 mm above the leaf base, the conspicuous secondary veins placed 3–13 mm in from margin, the inconspicuous secondary veins intramarginal to 3 mm in from margin, tertiary veins percurrent, oriented subperpendicular to midvein, 2–9 mm apart, connected by 1–3 quaternary veins, or not connected and quaternary veins reticulate, the higher order veins reticulate, the midvein and major secondary veins slightly impressed to flat, tertiary veins slightly impressed to more commonly flat, remaining veins flat on adaxial surface; the midvein strongly raised, the major secondary veins slightly to moderately raised, the minor secondary veins and tertiary veins slightly raised to flat, and the higher order veins flat on abaxial surface; adaxial surface appearing smooth and punctate to slightly wrinkled after drying, with scattered druse crystals, and drying darker than the abaxial surface, the indumentum initially of dense, pale ferrugineous, stellate hairs, but very quickly glabrescent, although scattered hairs often retained on lamina, and numerous hairs often retained on midvein and major secondary veins; abaxial surface pale green, the surface ± smooth, with dense to moderate (rarely sparse), ferrugineous to pale ferrugineous, stellate hairs (with arms predominantly radiating outward), 0.13–0.25 mm across, the veins with similar hairs, such hairs on lamina usually ± persistent, and those of primary, secondary, and even tertiary veins often deciduous (but sometimes persistent as well), mite domatia present or absent, usually not well developed, at junction of midvein and major secondary veins, with elongate, ± ferrugineous, barbate, eglandular hairs, 0.1–1 mm long. **Inflorescences** terminal, paniculate cymes, 5–22 cm long, 4–13 cm across, with 3–7 major branch pairs, the peduncle 1–6.6 cm long, the ultimate axes (pseudopedicels) 1–7 mm long, and the numerous flowers well separated from each other; bracts 0.7–1.5 × 0.2–0.3 mm, but probably also larger, narrowly triangular, with acute apex, quickly deciduous; bracteoles 0.4–1 × 0.1–0.25 mm, narrowly triangular, with acute apex, deciduous. **Flowers** 5- or occasionally 6-merous, zygomorphic (due to positioning of the stamens), with pedicel 1.5–6 mm long. **Hypanthium** 4.5–6 mm long, terete and slightly constricted above ovary, the free portion 2.5–3.5 mm long, 2–3 mm wide at the torus, the outer surface with moderate to dense stellate hairs, the internal surface smooth to very slightly longitudinally ridged, glabrous. **Calyx** lobes 5 (6), separate in bud, the tube 0.8–1.5 mm long, not tearing between lobes, with moderate to dense stellate hairs abaxially, with sparse to moderate branched to stellate hairs adaxially, the lobes 0.2–0.8 × 2–3.5 mm, broadly triangular to nearly obsolete, the apex obtuse to rounded, with hairs similar to those of the tube, green, sometimes red-tinged; calyx teeth present, 0.1–0.2 mm long, a small bump near apex of each lobe, green, with rounded apex, and hairs similar to those of calyx. **Petals** 5 (6), 7–11 × 3.5–6.5 mm, asymmetrically obovoid, spreading, white, glabrous but both surfaces densely papillose-granulate, the apex rounded and ± notched, the base slightly narrowed to a broad attachment, the margin entire. **Stamens** 10 (12), isomorphic, ± geniculate near filament apex; staminal filament 5.5–8 mm long, glabrous, pale yellow, anther thecae 5.2–7.9 × 0.8–1.2 mm, subulate, straight to slightly incurved, opening by a small dorso-apical pore, yellow, the connective not prolonged below the thecae, glabrous, but the filament emerging from slight depression in sterile, minutely dorso-lobed anther base. **Ovary** 3-locular, 3/4–4/5 inferior, ellipsoid to oblong, 4–4.5 mm long, 1.7–3 mm in diameter, apically conical, glabrous, the apex with small, ridged collar, but lacking crown, with axile placentation, the ovules numerous, borne on small placenta that only slightly extends into locule; style 12–18.5 mm long, distally curved, white to rose, glabrous; stigma punctate, minutely papillose, 0.15–0.2 mm wide. **Berries** 6–10 mm long, 5.5–10 mm in diameter, globose to ellipsoid, purple-black, with scattered, stellate hairs, the hypanthium constricted, 1.5–2.7 mm wide at narrowest point and 2.5–3.3 mm wide at torus, but appearing strongly constricted due to flaring calyx tube. **Seeds** 1–2 mm long, angular-obovoid, with ± rectangular raphe, the testa smooth to ± roughened due to bulging cells, but the raphe smooth; appendage absent.

Chromosome number.—$2n = 34$ (Wurdack & Solt 1980).

Phenology.—Recorded in flower in every month except April, October, and December, and likely blooming year around.

Distribution and habitat.—Miconia angustiflora is endemic to Jamaica, occurring nearly throughout the island (Fig. 8), usually in dry to moist thickets or forests over limestone, from 90–900 m.

Additional specimens examined. **JAMAICA. Clarendon Parish:** between Lluidas Vale and Croft Hill, 520 m, 16 Jul 1962, *Fosberg 42715* (US); Peckham woods, 2500 ft, 6 Jul 1911, *Harris 10961* (NY, US); ibid., 27 Sep 1912, *Harris 11176* (F, NY, US). **Hanover Parish:** Campbellton Hall, 300–400 ft, 22 Dec 1960, *Adams 8649* (MO); Green Island and vicinity, Fish River Mountains, 13–15 Mar 1908, *N.L. Britton & Hollick 2165* (NY); Hopewell, 500 ft, 26 Jun 1975, *Clarkson & Kress 75-123* (DUKE); Askenish, Dolphin Head, 29 Jun 1975, *Clarkson et al. 75-142* (DUKE); NE of Dolphin Head, 20 Mar 1908, *Harris 10316* (F, NY, US); Dolphin Head, SW of Askenish, ca. 7 mi S of Lucea, 270–300 m, 12 May 1987, *Judd 5302* (F, FLAS, GH, IJ, MO); Dolphin Head, E side, 1200 ft, 22 Aug 1952, *Proctor 7184* (IJ); lower slopes between Askenish and Dolphin Head, 900–1250 ft, 28 Jun 2001, *Proctor 51899* (IJ); Dolphin Head, on the top, 535 m, 9 Jul 1986, *Skean 1841* (IJ, NY); NE slopes of Dolphin Head, 330 m, 9 Jul 1986, *Skean 1854* (IJ, MO, US); Quashiba Mountain, 1 mi W of Georges Plain, 1100–1300 ft, 29 Jul 1954, *Webster & Wilson 5092* (IJ, MICH, S, US). **Manchester Parish:** Lincoln, 3–7 Sep 1908, *N.L. Britton 3108* (NY); Marshall's Pen, 21–23 Sep 1908, *N.L. Britton 3704* (NY); vicinity of Mandeville, 15–26 Feb 1910, *Brown 266* (NY, US); Limestone Hill at Banana Ground, 2900 ft, 14 Jul 1963, *Crosby et al. 656* (DUKE, F, MICH, MO, MSC, NY); near Troy, 2000 ft, 30 Jun 1904, *Harris 8744* (F, FLAS, NY, S, US); 0.5 mi NW of Christiana, 3000 ft, 3 Jul 1955, *Howard & Proctor 14341* (A, IJ); 2.25 mi NW of Mandeville, Marshall's Pen, 18°5'N, 77°30'W, 700 m, 1 Jun 1983, *Landrum 4745* (NY); Mandeville, Marshall's Pen, 750 m, 19 Nov 2000, *Parker & Proctor 3447* (IJ); 0.5 mi NW of Christiana, 3000 ft, 22 Oct 1955, *Proctor 11040* (IJ, NY, US); Marshall's Pen, 2.25 mi NW of Mandeville, 2100–2300 ft, 28 Jul 1968, *Proctor 28893* (IJ, NY, US); Cross Keys, 2000–3000 ft, Aug 1954, *Robertson 1249* (NY). **Portland Parish:** slopes above Uncommon Hill, above Fruitful Vale, 1000–2250 ft, 17 Aug 1962, *Proctor 22615* (IJ, MICH, NY). **St. Andrew Parish:** Red Hills, 1500 ft, 7 July 1960, *Adams 7525* (DUKE); Mona Hill, vicinity of Kingston, 11–12 Sep 1906, *N.L. Britton 366* (NY); Cooper's Hill, Red Hills, NW of Kingston, 2300 ft, 7 Aug 1963, *Crosby & Anderson 1117* (DUKE, F, MICH, MSC, NY); Stony Hill, Nov 1898, *Fawcett & Harris 7462* (A, GH, NY, S, US); Halls Delight, 334 m, 15 Jun 1895, *Harris 5512* (F, US); Constant Spring to Bardowie, 800 ft, 27 Jul 1915, *Harris 12089* (F, GH, MO, NY, S, US); between Mavis Bank and Gordon Town, between mile marker 13 and 14, 760 m, 18 May 1987, *Judd 5363* (IJ); Hermitage Dam and vicinity, 500 m, 3 Jun 1926, *Maxon 8787* (GH, S, US); Stony Hill, 19 Jul 1949, *Newill s.n.* (IJ); ibid., 1500 ft, 14 Jul 1952, *Newill s.n.* (IJ). **St. Ann Parish:** 1 mi S of Crescent Park, vicinity of Lydford Post Office, 1750 ft, 20–31 Dec 1953, *Howard & Proctor 13548* (A, IJ); Hopewell, 2 Feb 1938, *Hunnewell 15328* (GH, NY); near Bamboo, 11 Feb 1948, *Hunnewell 18834* (NY); Mount Diablo region, lower slopes of Hollymount, 1 mi S of Faiths Pen, 500–575 m, 28 May 1987, *Judd 5512* (F, FLAS, IJ, NY); vicinity of Lime Hall, 1000–1250 ft, 25 Jun 1954, *Lewis s.n.* (IJ); vicinity of Mosely Hall Cave, near Blackstonedge, 2000 ft, 24 Aug 1952, *Proctor 7206* (HAC, IJ, NY); rd from Jamaica A-1 to Hollymount on Mt. Diablo, 1700 ft, 6 Jul 1967, *R.E. & S. Weaver 902* (DUKE, GH). **St. Catherine Parish:** on A-1 0.7 mi S of St. Ann/St. Catherine boundary, lower slopes of Mt. Diablo, 18°12.392'N, 77°5.675'W, 526–530 m, *Judd 8309* (FLAS, IJ, NY); 0.6 mi SE of Guys Hill, 1600 ft, 3 May 1952. *Proctor 6653* (IJ, US); 3 mi W of Lluidas Vale, 1750 ft, 11 Jun 1965, *Proctor 26441* (IJ); near Sligoville, 9 Aug 1947, *van der Porten s.n.* (IJ); 1 mi E of Top Hill, 550 m, 10 Oct 1969, *Wurdack & Solt 2616* (NY, US). **St. Elizabeth Parish:** Santa Cruz Mountains, 12 Sep 1907, *N.L. Britton 1296* (NY); Munro College, 2600 ft, Aug 1944, *Snee s.n.* (IJ). **St. Mary Parish:** Cabarita Island, off Port Maria, 150 ft, 29 Dec 1952, Proctor 7552 (IJ). **St. Thomas Parish:** Serge Island, 15–19 Sep 1908, *N.L. Britton 3655* (NY). **Trelawny Parish:** from Burnt Hill to Ramgoat Cave, 18°25'N, 77°33'W, 500 m, *Acevedo-Rdgz. 9569* (US); Cockpit Country, near Barbecue Bottom, 14 Aug 1963, *Crosby & Anderson 1209* (DUKE, F, GH, MICH, MSC, NY); 2–3 mi N by road of Burnt Hill crossroads, 1300 ft, 16 Aug 1965, *Hespenheide 1289* (DUKE, FLAS, GH, MICH, MO, MSC, NY, US); 0.6–1 mi N of Spring Garden, 1750–2000 ft, 1 Nov 1975, *Proctor 35429* (IJ, MO).

Miconia angustiflora is variable in the development of mite domatia; some individuals have mite domatia on the abaxial leaf surface, while others lack them. The domatia, when present, are usually poorly developed. The species often has been confused with *T. bicolor* (Goldenberg et al. 2013), although the form of the hairs (i.e., stellate hairs vs. stellate-peltate scales) easily differentiate the two taxa. It is actually much more similar to *M. barbata* and *M. maestrensis*, two species of the "Oriente" region of Cuba (see key for differentiating characters), although we note that the latter species also have been confused with *T. bicolor.*

The species has almost always been known as *Tetrazygia pallens* (see, for example, Proctor 1972) although this name actually is a synonym of *T. bicolor* (see Michelangeli & Bécquer 2012, and nomenclatural discussion under *Miconia bicolor*, above). The misapplication of the name *Tetrazygia pallens*, originally described from Hispaniolan material, came about as a result of the broad circumscription of *Tetrazygia pallens* in Cogniaux (1891), which included plants from Jamaica, Hispaniola, and eastern Cuba; the name *T. pallens* was then erroneously applied to the Jamaican populations when the circumscription of this species was restricted.

7. Miconia cajalbanensis Judd, Bécquer, & Majure, nom. nov. (**Fig. 6C**). *Tetrazygia coriacea* Urb., Repert. Spec. Nov. Regni Veg. 22:225. 1926, non *Miconia coriacea* DC., Prodr. 3:189. 1828. TYPE: CUBA [PROV. PINAR DEL RÍO]: without definite locality, 1860–1864, fl, *Wright 1222 p.p.* (LECTOTYPE, here designated, because holotype at B destroyed: S!; ISOLECTOTYPES: CAS on-line image #0004793!, HAC!, NY!, S!).

Evergreen **shrub or tree** to 5 m. Young **stems** terete to slightly quadrangular, the indumentum of dense,

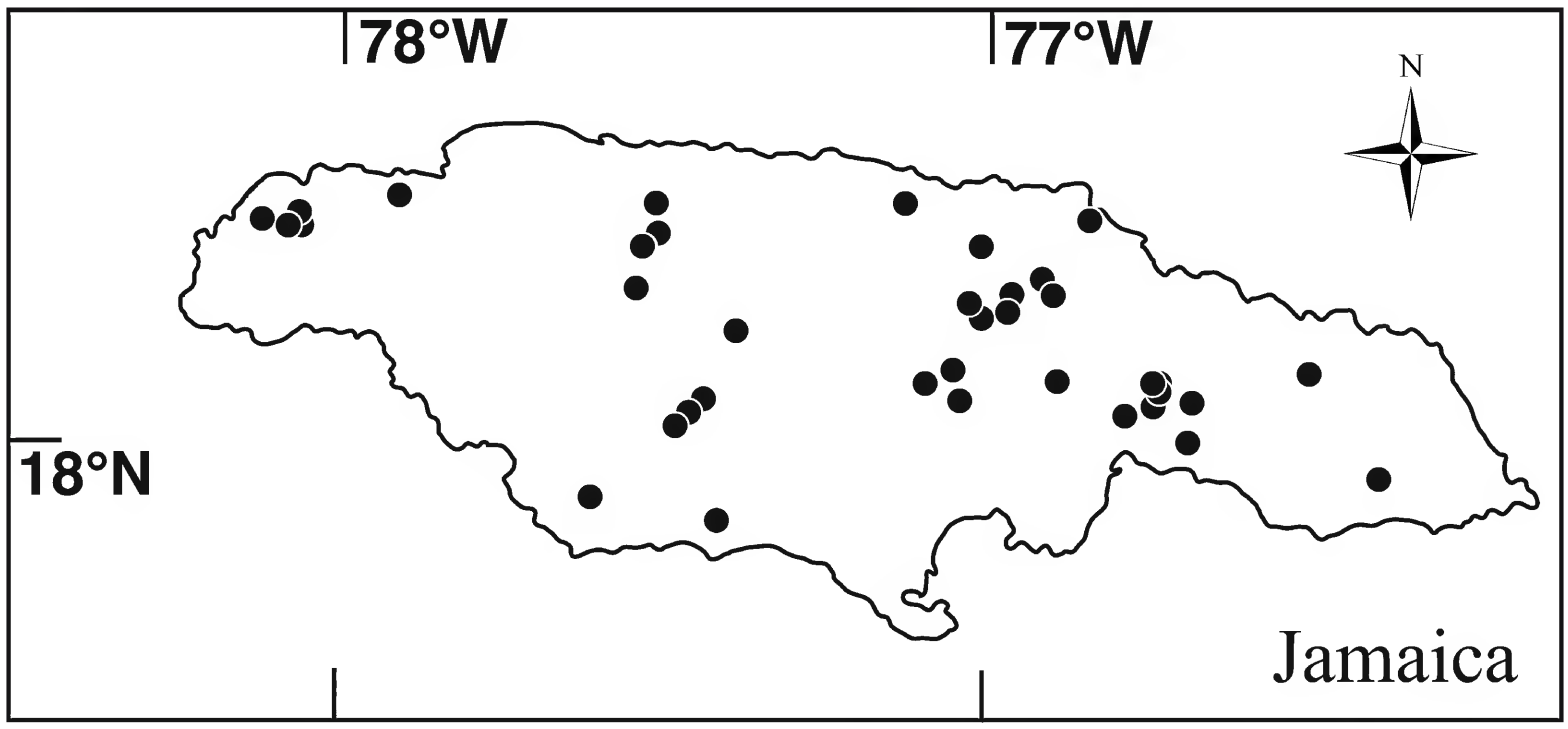


Fig. 8. Distribution of *Miconia angustiflora* in Jamaica.

ferrugineous, stellate hairs, without elongate, multicellular, non-glandular hairs, internodes 0.6–3.3 cm long, lacking longitudinal ridges, nodal line absent. **Leaves** isophyllous or nearly so; petiole 0.7–2.7 cm long, the indumentum of dense, ferrugineous, stellate hairs; the blade 3.4–10 × 1.3–3.5 cm, ovate to elliptic or oblong, not falcate, coriaceous, the apex acuminate, the base obtuse to rounded (or very slightly cordate), the margin plane to revolute, entire; secondary veins 2 pairs, one pair conspicuous and one pair inconspicuous, acrodromous, basal, the innermost pair joining midvein at base to 1 mm above the leaf base, the conspicuous secondary veins placed 1.8–5.5 mm in from margin, the inconspicuous secondary veins intramarginal to 1 mm in from margin, tertiary veins percurrent, oriented subperpendicular to midvein, 1.7–6 mm apart, connected by 1 quaternary vein, or not connected by quaternary veins, and these reticulate, the higher order veins reticulate, the midvein and major secondary veins impressed, tertiary veins very slightly impressed to flat, remaining veins flat on adaxial surface; the midvein strongly raised, the major secondary veins moderately to slightly raised, the minor secondary veins and tertiary veins flat to very slightly raised, and the higher order veins flat on abaxial surface; adaxial surface appearing slightly wrinkled after drying, with scattered druse crystals, and drying darker than the abaxial surface, the indumentum initially of dense, ferrugineous, stellate hairs, but very quickly glabrescent, although a few often persisting on lamina, and numerous such hairs often persisting on primary and secondary veins, especially the proximal portions thereof; abaxial surface pale green but appearing ferrugineous due to the indumentum, the surface distinctly bullate, with moderate to dense, ferrugineous, stellate hairs, 0.07–0.22 mm across, the veins with similar hairs, such hairs on lamina and veins persistent; mite domatia absent. **Inflorescences** terminal, paniculate cymes, 4–15.3 cm long, 4–8 cm across, with 2–5 major branch pairs, the peduncle 1.8–5 cm long, the ultimate axes (pseudopedicels) 1.7–5.5 mm long, and the numerous flowers well separated from each other; bracts 0.5–1.5 × 0.15–0.3 mm, and probably also larger, narrowly triangular, with acute apex, very quickly deciduous; bracteoles 0.3–0.8 × 0.1–0.2 mm, narrowly triangular, with acute apex, quickly deciduous. **Flowers** 5- or occasionally 6-merous, zygomorphic (due to positioning of the stamens), with pedicel 1–3 mm long. **Hypanthium** 6.5–7.5 mm long, terete and not or only slightly constricted above ovary, the free portion 3.5–4.5 mm long, 2.5–4 mm wide at the torus, the outer surface with moderate to dense stellate hairs, the internal surface smooth to very slightly longitudinally ridged, glabrous. **Calyx** lobes 5 (6), separate in bud, the tube 2–3.3 mm long, not tearing between lobes, with moderate stellate hairs abaxially, and moderate to dense branched to stellate hairs adaxially, the lobes 0.2–0.7 × 2–4 mm, broadly triangular to nearly obsolete, the apex rounded, with hairs similar to those of the tube, green, often red- tinged; calyx teeth present, 0.2–0.5 mm long, a rounded to conical bump near apex of each lobe or merely a raised line along

midrib of lobe, green to red, with rounded to acute apex, and hairs similar to those of calyx. **Petals** 5 (6), 9–11 × 4.5–6.5 mm, asymmetrically obovate, spreading, white, often pink- tinged, glabrous but both surfaces densely papillose-granulate, the apex ± rounded, the base slightly narrowed to a broad attachment, the margin entire. **Stamens** 10 (12), isomorphic, ± geniculate near filament apex; staminal filament 7–7.5 mm long, glabrous, pale yellow, often pink-tinged, anther thecae 6.5–8.3 × 0.8–1.3 mm, subulate, straight to slightly incurved, opening by a small dorso-apical pore, yellow, often pink-tinged, the connective not prolonged below the thecae, glabrous, but the filament emerging from slight depression in sterile, minutely dorso-lobed anther base. **Ovary** 3-locular, ca. 3/4 inferior, ellipsoid to oblong, 4.3–5 mm long, 1.7–3 mm in diameter, apically conical or cylindric-conical, glabrous, the apex with a small, ridged collar, but lacking a crown, with axile placentation, the ovules numerous, borne on a small placenta that only slightly extends into locule; style 15–17 mm long, distally curved, white to pink, glabrous; stigma punctate, minutely papillose, 0.15–0.2 mm wide. **Berries** 5–9.5 mm long, 5.5–8 mm in diameter, globose to ellipsoid, purple-black, with scattered stellate hairs, the hypanthium constricted, 2–2.3 mm wide at narrowest point and 2.5–3 mm wide at torus, but appearing strongly constricted due to flaring calyx tube. **Seeds** 1.3–2 mm long, angular-obovoid, with ± rectangular raphe, the testa distinctly roughened due to bulging cells, except at distal end where cells ± smooth, however, raphe smooth; appendage absent.

Phenology.—Collected in flower from April to July.

Distribution and habitat.—*Miconia cajalbanensis* is endemic to the Cajálbana region, Prov. Pinar del Río, Cuba (Fig. 5), where it occurs in xeromorphic scrub and pinelands on serpentine soil from 150–470 m.

Additional specimens examined: **CUBA. Prov. Pinar del Río:** La Palma, La Cajálbana, 26 Jan 1950, *Acuña H-ROIG-9043* (HAC); La Cajálbana, 10 Jun 1950, *Acuña et al. SV-16187* (HAC); Cajálbana, La Palma, 1 Oct 1949, *Bro. Alain & Acuña 1119* (HAC, NY); Cuabales de Cajálbana, La Palma, 3 Dec 1949, *Bro. Alain & Acuña 1199* (HAC); ibid., *Acuña & Bro. Alain SV-15699* (HAC); W of Loma Cajálbana, La Palma, 3 Apr 1954, *Bro. Alain 3899* (GH, HAC, NY); W of Cajálbana, 7 Dec 1955, *Bro. Alain 4495* (GH, HAC, US); Bahía Honda, Sierra de Cajálbana, subida al Tecnológico Invasión de Occidente, 300 m, 15 Jul 1989, *Álvarez de Zayas & Pujadas HFC-70172* (HAJB); ibid., *Álvarez de Zayas & Pujadas HFC-70175* (HAJB); ibid., *Álvarez de Zayas & Pujadas HFC-70176* (HAJB p.p.); ibid., *Álvarez de Zayas & Pujadas HFC-70177* (HAJB); Cajálbana, Oct 1975, *Armenteros s.n.* (HAJB); Mpio. La Palma, Cajálbana, carretera a Mil Cumbres, sendero ecoturístico, 7 May 2004, *Bécquer & Abbott HFC-82423* (FLAS, HAJB); La Palma, Loma de Cajálbana, falda O, Apr 1967, *Bisse & Rojas HFC-1942* (HAJB); Bahía Honda, parte oriental de la Loma de Cajálbana, Jul 1968, *Bisse HFC-9567* (HAJB); La Palma, pinares de Cajálbana, Oct 1975, *Bisse et al. HFC-28608* (HAJB); La Palma, Cajálbana, 28 Dec 1974, *Bisse et al. HFC-29316* (HAJB); Consolación del Norte, falda S de la loma peluda (Preluda) de Cajálbana, 15 Oct 1976, *Bisse et al. HFC-32604* (HAC, HAJB); La Palma, Altiplano de Cajálbana, cerca d el Tecnológico forestal, 350 m, Dec 1980, *Bisse et al. HFC-45507* (HAJB); Loma Cajálbana, pinar de la cumbre, 450–470 m, 5 Jul 1970, *Borhidi & Vásquez 8000 SV-33414* (HAC); ibid., *Borhidi & Vásquez SV-33417* (HAC); La Palma, ladera S de Cajálbana, entre Sagua y El Sitio, 22°45'N, 83°30'W, 150 m, 16 Jul 1996, *Cedeño 1234* (NY); Loma de Cajálbana in "Cuabal", 10 Mar 1920, *Ekman 10481* (S); Cajálbana, 200–300 m, Nov 1975, *García & Sánchez s.n.* (HAJB); La Palma, Arroyo de Morto, Sierra de Cajálbana, ladera S, 22°46'NH, 83°26'W, 14 Sep 1999, *Kuba-Exkursion Uni Frankfurt/M 1999 no. 13* (FR n.v., S); ibid., 17 Sep 1999, *Kuba-Exkursion Uni Frankfurt/M 1999 no. 112* (FR n.v., S); Cajálbana, ladera al NE del Tecnológico Forestal, 400 m, 21 Jan 1981, *Martinez C. SV-36145* (HAC); Monte La Cajálbana, 4 Feb 1956, *Morton 9820* (US); Cajálbana, 1 Nov 1975, *Plasencia s.n.* (HAJB); pinares sobre serpentine de Cajálbana, en la ladera S, 5 May 1988, *Urquiola et al. HPR-4501* (HAJB); La Cajálbana, Jan 1967, *Yero M. 677* (HAC); ibid., Jul 1965, *Yero M. 1093* (HAC).

Miconia cajalbanensis is phenetically distinctive because of its fairly small stellate hairs and distinctly bullate abaxial leaf epidermis (see key). Its seeds are also noteworthy, having bulging testa cells, in contrast to most species of the *M. bicolor* complex, which have more or less smooth testa cells. Despite these distinctive characters, it has frequently been confused with the more widespread and common *M. bicolor*, a species with an abaxial leaf indumentum of stellate-peltate scales.

The new name *M. cajalbanensis,* required since the epithet "coriacea" is occupied in *Miconia*, reflects the fact that this species is endemic to the vicinity of Cajálbana, Cuba. This is a region of exceptional endemism, with ca. 40 endemic species and several endemic genera (Borhidi and Muñiz 1985; Berazaín 1987; Borhidi 1991). *Miconia cajalbanensis* is considered to be critically endangered in Cuba (Berazaín 2005).

8. Miconia cristalensis (Borhidi) Judd, Bécquer, & Majure, comb. nov. *Tetrazygia cristalensis* Borhidi, Acta Bot. Acad. Sci. Hung. 23:37. 1977 [1978]. TYPE: CUBA. [PROV. SANTIAGO DE CUBA:] entre Los Mulos y Corea, 2100–2200 ft, Sierra de Cristal, 27–28 Aug 1959, *M. López Figueiras UO-279* (HOLOTYPE: HAC!; ISOTYPES: HAC!, HAJB!, NY!).

Evergreen **shrub to small tree** up to 4 m. Young **stems** terete to quadrangular, the indumentum of dense, ferrugineous, globular-stellate to dendritic hairs, without elongate, multicellular, non-glandular hairs, internodes 0.9–3.5 cm long, lacking longitudinal ridges, nodal line present, faint to prominent. **Leaves** isophyllous or nearly so; petiole 1–2.6 cm long, the indumentum of dense, ferrugineous, globular-stellate hairs; the blade 4.6–14 × 1.8–4.4 cm, ovate to elliptic, coriaceous, not falcate to slightly falcate, the apex acuminate, the base obtuse to rounded, the margin plane to revolute, entire to slightly undulate; secondary veins two pairs, one pair conspicuous and one pair inconspicuous, acrodromous, basal, the innermost pair joining midvein at base to 2 mm above the leaf base, the conspicuous secondary veins placed 2–7.5 mm in from margin, the inconspicuous secondary veins intramarginal to 1.5 mm in from margin, tertiary veins percurrent, oriented subperpendicular to midvein, 1.5–7 mm apart, connected by 1 or 2 quaternary veins, or quaternary veins reticulate, not connecting tertiary veins, the higher order veins reticulate, the midvein and major secondary veins slightly to moderately impressed, tertiary veins slightly impressed to flat, remaining veins slightly impressed to flat on adaxial surface; the midvein strongly raised, the major secondary veins strongly to moderately raised, the minor secondary veins and tertiary veins slightly raised, and the higher order veins slightly raised to flat on abaxial surface; adaxial surface appearing slightly wrinkled after drying, with scattered druse crystals, and drying darker than the abaxial surface, the indumentum initially of dense, brunnescent to ferrugineous, globular-stellate hairs, but quickly glabrescent, although some hairs persisting proximally on midvein and major secondary veins; abaxial surface pale green but appearing brunnescent to ferrugineous due to indumentum, the epidermal surface ± smooth, with dense, brunnescent to ferrugineous, globular-stellate hairs (with arms pointing upward to radiating outward), 0.16–0.28 mm across, the veins with similar hairs, such hairs on lamina and veins persistent, mite domatia absent. **Inflorescences** terminal, paniculate cymes, 3–5 cm long, 2–4 cm across, with 1–3 major branch pairs, the peduncle 1.5–3.3 cm long, the ultimate axes (pseudopedicels) 2–7 mm long, and numerous flowers well separated from each other; bracts not seen, presumably triangular, very quickly deciduous; bracteoles not seen, presumably ± triangular, deciduous. **Flowers** 5-merous, zygomorphic (due to positioning of the stamens), with pedicel 1–2 mm long. Hypanthium 6.5–8 mm long, terete and slightly to distinctly constricted above ovary, the free portion 2.5–4 mm long, 2.3–3 mm wide at the torus, the outer surface with moderate to dense globular-stellate hairs, the internal surface very slightly longitudinally ridged, glabrous. **Calyx** lobes 5, separate in bud, the tube 0.9–2 mm long at late anthesis (only old flowers seen), not tearing between the lobes, with moderate to dense globular-stellate hairs adaxially and abaxially, the lobes 1.7–3.5 x 1–3.5 mm, ± triangular, the apex acute to rounded, with hairs similar to those of the tube, green, often red-tinged; calyx teeth present, 0.2–1 mm long, merely a ridge along lobe to a ridge with short apical bulge or projection, green or reddish, with rounded apex, and hairs similar to those of calyx. **Petals** 5, 6–7.5 × 5–6 mm, asymmetrically obovate, spreading, white, glabrous but both surfaces densely papillose-granulate, the apex rounded, the base slightly narrowed to a broad attachment, the margin entire. **Stamens** 10, not seen. **Ovary** 3-locular, 2/3–4/5 inferior, apically conical, glabrous, the apex with a small, slightly ridged collar but lacking a crown, with axile placentation, the ovules numerous, borne on a small placenta not extending or only slightly extending into locule; style not seen. Berries 6–8 mm long, 5–6 mm in diameter, ellipsoid, purple-black, with sparse to moderate globular-stellate hairs, the hypanthium strongly constricted, 2–2.5 mm wide at narrowest point and 3–3.5 mm wide at torus. **Seeds** 1.7–2 mm long, angular-obovoid, with ± rectangular hilum, the testa ± smooth; appendage absent.

Phenology.—Only collected in flower in August.

Distribution and habitat.—*Miconia cristalensis* is endemic to the Sierra de Cristal (Prov. Santiago de Cuba), Cuba (Fig. 7), occurring from 630–800 m in pine forests and thickets on serpentine or gabbro.

Additional specimens examined: **CUBA. Prov. Santiago de Cuba:** Sierra de Cristal, Mpio. Segundo Frente, ladera SE del Pico Cristal, subida al firme desde la intersección del camino del Oro a Batista y La Zanja, 700 m, 26 Apr 2004, *Bécquer HFC-82262* (FLAS, HAJB); Segundo Frente, Sierra Cristal, camino de San Nicolías al Oro, cerca del cruce del río Miguel, 3 Nov 2005, *Bécquer et al. HFC-83729* (HAJB); Mayarí Arriba, Sierra de Micara, 800 m, Jun 1967, *Bisse & Rojas HFC-4233* (HAJB).

Miconia cristalensis is very poorly collected, but apparently is most closely related to *M. maestrensis* (see key for differentiating characters) and *M. barbata*, from which it differs in the lack of mite domatia and in its longer

calyx lobes. The three species are likely reproductively isolated, as *M. maestrensis* occurs only in the Sierra Maestra and *M. barbata* in the Sierra de Nipe and other areas in northern "Oriente" (Fig. 7); however both *M. maestrensis* and *M. barbata* likely co-occur with the widespread *M. bicolor.* They are at least broadly sympatric geographically, and more fieldwork is needed to investigate subtle ecological differences.

9. Miconia maestrensis Judd, Bécquer, & Majure, nom. nov. (**Fig. 6D**). *Miconiastrum lambertianum* Bonpl. ex Naudin, Ann. Sci. Nat., Bot., ser. 3. 15:341, t. 17. 1850, non *Miconia lambertiana* DC., Prodr. 3:185. 1928. TYPE: CUBA [PROV. SANTIAGO DE CUBA]: St. Jago de Cuba, Nima-nima, Aug 1844, *Linden 2081* (LECTOTYPE, chosen by Martin & Cremers, J. Bot. Soc. Bot. France 37:40. 2007, P on-line image #481686!; ISOLECTOTYPE, NY, 2 sheets!, P on-line image #481687!).

Evergreen **shrub or tree** to 5 m. Young **stems** terete to slightly quadrangular, the indumentum of dense, ferrugineous, globular-stellate to dendritic hairs, without elongate, multicellular, non-glandular hairs, eventually ± glabrescent, internodes 0.7–10.8 cm long, lacking longitudinal ridges, nodal line present, faint. **Leaves** isophyllous or nearly so; petiole 1.8–3 cm long, the indumentum of dense, ferrugineous, globular-stellate to stellate hairs; the blade 4.7–15.5 × 1.8–5.6 cm, ovate to elliptic, not falcate to slightly so, ± coriaceous, the apex acuminate to attenuate, the base acute to obtuse or rounded, the margin plane to slightly revolute, entire; secondary veins 2 pairs, one pair conspicuous and one pair inconspicuous, acrodromous, basal, the innermost pair joining midvein at base to 3 mm above the leaf base, the conspicuous secondary veins placed 3–8 mm in from margin, the inconspicuous secondary veins intramarginal to 1.3 mm in from margin, tertiary veins percurrent, oriented subperpendicular to midvein, 1.7–10 mm apart, connected by 1 or 2 quaternary veins, or not connected by such veins, and quaternary veins ± reticulate, the higher order veins reticulate, the midvein and major secondary veins slightly impressed to flat, tertiary veins very slightly impressed to flat, remaining veins flat on adaxial surface; the midvein strongly raised, the major secondary veins moderately to slightly raised, the minor secondary veins and tertiary veins flat to very slightly raised, and the higher order veins flat on abaxial surface; adaxial surface appearing slightly wrinkled after drying, with scattered druse crystals, and drying darker than the abaxial surface, the indumentum initially of ± dense, stellate hairs, but very quickly glabrescent, although a few hairs often persisting on proximal portion of midvein and major secondary veins; abaxial surface pale green, but appearing ferrugineous to pale ferrugineous due to dense indumentum, the epidermal surface ± smooth, with dense, ferrugineous to pale ferrugineous, stellate hairs (with arms pointing upward to radiating outward), 0.13–0.24 mm across, the veins with similar hairs, such hairs on lamina and veins persistent; mite domatia absent. **Inflorescences** terminal, paniculate cymes, 3.5–13 cm long, 2.5–6 cm across, with 1–4 major branch pairs, the peduncle 0.8–4 cm long, the ultimate axes (pseudopedicels) 1.5–5.5 mm long, and the numerous flowers well separated from each other; bracts not seen, but presumably triangular, very quickly deciduous; bracteoles ca. 0.4 × ca. 0.15 mm, narrowly triangular, with acute apex, deciduous. **Flowers** 5-merous, zygomorphic (due to positioning of the stamens), with pedicel 1–3 mm long. Hypanthium 6–6.5 mm long, terete and slightly constricted above ovary, the free portion 2.4–2.8 mm long, 2–2.5 mm wide at the torus, the outer surface with dense stellate hairs, the internal surface smooth to very slightly longitudinally ridged, glabrous. **Calyx** lobes 5, separate in bud, the tube 0.7–1 mm long, not tearing between lobes, with ± dense stellate hairs adaxially, and dense to moderate branched to stellate hairs adaxially, the lobes 0.3–0.6 × 2.5–3 mm, broadly triangular, the apex obtuse to rounded, with hairs similar to those of the tube, green to red-tinged; calyx teeth present, 0.1 mm long, merely a small bump near apex of lobe, green, with rounded apex, and hairs similar to those of calyx. **Petals** 5, 6.3–7 × 3.4–5 mm, asymmetrically obovate, spreading, white, glabrous but both surfaces densely papillose-granulate, the apex rounded, the base slightly narrowed to a broad attachment, the margin entire. **Stamens** 10, isomorphic, ± geniculate near filament apex; staminal filament 5.5–7 mm long, glabrous, color unknown, anther thecae 4.8–6 × 0.7–1 mm, subulate, straight to slightly incurved, opening by a small dorso-apical pore, yellow, the connective not prolonged below the thecae, glabrous, but the filament emerging from slight depression in sterile, minutely dorso-lobed anther base. **Ovary** 3-locular, 2/3–4/5 inferior, apically conical, glabrous, the apex with a small, slightly ridged collar but lacking a crown, with axile placentation, the ovules numerous, borne on a small placenta not or only slightly extending locule; style 12–16 mm long, distally curved, white, glabrous; stigma punctate, minutely papillose, 0.15–0.2 mm wide. **Berries**

[nearly mature] 5.5–10 mm long, 4.5–6 mm in diameter, globose to ellipsoid, green [but presumably turning purple-black], with scattered to moderate, stellate hairs, the hypanthium strongly constricted, 1.5–2.3 mm wide at narrowest point and 2.3–2.7 mm wide at torus, but appearing wider due to flaring calyx tube. **Seeds** 1.5–2 mm long, angular-obovoid, with ± rectangular hilum, the testa ± smooth; appendage absent.

Phenology.—Only known to flower in August, but very poorly collected, and surely with a broad flowering period, as mature fruits have also been collected in August.

Distribution and habitat.—*Miconia maestrensis* occurs in Cuba, in the Sierra Maestra and associated lower elevation habitats, in southern "Oriente" (Prov. Granma, and Santiago de Cuba), in moist forests, on limestone, near rivers or arroyos, at low elevations to 935 m (Fig. 7).

Additional specimens examined: **CUBA. Prov. Granma:** Sierra Maestra, Mun. Buey Arriba, Barrio Nuevo a Pata la Mesa, cerca 4 km al SE de El Manguito, 13 May 1988, *Alvarez de Zayas et al. HFC-64310* (B, HAJB); Buey Arriba, Guamá, Barrio Nuevo a Peladero, 24 May 1988, *Alvarez de Zayas et al. HFC-65244* (HAJB); Sierra Maestra, Río Yara, 6 Jul 1922, *Ekman 14188* (S); Sierra Maestra, on the edge of Arroyo Corrojo, near Nagua, 20 Aug 1922, *Ekman 14920* (GH, S); Península de Cabo Cruz, between Río Nuevo and the coast, 16 Jan 1923, *Ekman 16150* (GH, HAC, S); Bartolome Masó, Parque Nacional Turquino, sendero Alto del Naranjo-Pico Turquino, entre Alto del Naranjo y La Platica, 20°0'53"N, 76°53'44.5"W, 935 m, 8 Nov 2013, *Michelangeli et al. 2209* (HAJB, NY). **Prov. Santiago de Cuba:** St. Jago de Cuba, Nima-nima, 1834–1844, *Linden 2091* (NY, P on-line image).

Miconia maestrensis, although early described, has long been known as either *Tetrazygia pallens* (see Cogniaux 1891) or *T. bicolor* (e.g., identifications on specimens such as *Ekman 14188* or *Ekman 14920*). This species is distinguished from *T. bicolor* by its indumentum of stellate hairs (not stellate-peltate scales, see key), and is phenetically most similar to *M. cristalensis*. It differs from *M. cristalensis* by the characters indicated in the key (note especially its much shorter calyx lobes). *Miconia maestrensis* is easily distinguished from *M. barbata* by the lack of mite domatia. It appears to be reproductively isolated from both *M. cristalensis* and *M. barbata*, since they occur in northern "Oriente" (Fig.7). *Miconia maestrensis* has been very poorly collected, and additional collections would improve our understanding of its pattern of variation and geographical distribution. The specimen *Álvarez de Zayas et al. HFC 64310* is tentatively considered to represent this species; only a photo has been seen by the first author, and it appears to be more densely pubescent than other material examined. Perhaps the variation exhibited among the specimens here considered within *M. maestrensis* actually represents that of more than one species, but a broad circumscription is here advocated due to the current paucity of herbarium material.

An epithet is unavailable in *Miconia* since *Miconiastrum lambertianum* cannot be transferred. We have therefore chosen the new name *Miconia maestrensis*, highlighting the distinctive geographical range of this species.

ACKNOWLEDGMENTS

We thank Norris Williams, Keeper of the University of Florida Herbarium (FLAS), Kent Perkins, Collections Manager, and Gretchen Ionta for assistance in processing specimens. We also thank the curators and staff of the herbaria (A, F, FTG, GH, JBSD, MICH, MO, NY, S, and US) who generously provided specimens on loan. Milcíades Mejía, Thomas A. Zanoni, Daisy Castillo, Alain H. Liogier, Teodoro Clase, Ricardo García, Francisco Jiménez, and Brígido Peguero assisted in several visits of the first and third authors to the herbarium (JBSD) of the Jardin Botánico Nacional, Dominican Republic. Keron C. St. E. Campbell graciously assisted in the visit of the first author to the herbarium (IJ) of the Natural History Museum of Jamaica, Institute of Jamaica. Bret Jestro assisted during the visit of the first author to the herbarium (FTG) of the Fairchild Tropical Botanic Garden; Anita Cholewa assisted during the visit to the University of Minnesota herbarium (MIN) and Alan Prather during the visit to the Michigan State University herbarium (MSC). We thank the administrators of the Herbario Rafael M. Moscoso (UCMM) at the Pontificia Universidad Catolica Madre y Maestra, Santiago, República Dominicana, the Herbario de la Academia de Ciencias (HAC), La Habana, Cuba, the Herbario del Jardín Botánico Nacional (HAJB), La Habana, Cuba, and the herbarium of Instituto Superior Pedagógico de Pinar del Río (HPPR) for their assistance. Finally, we thank Bruce F. Hansen for making available digital images of the holdings of *Miconia bicolor* at the herbarium (USF) of the University of South Florida. Numerous individuals helped

in field work, most notably J. Richard Abbott, Reed Beaman, Gretchen M. Ionta, John Kress, and Tim McDowell. We are grateful that Richard Abbott has allowed use of his beautiful photos of *Miconia bicolor* (Fig. 3A, B), *M. cajalbanensis* (Fig. 6C), *M. delicatula* (Fig. 1A), and *M. guajaibonensis* (Fig. 3C, D), and to Nicolas Garcia for his photo of fruiting *M. bicolor* (Fig. 1D). One anonymyous reviewer and Lynn Bohs (U) provided helpful comments on an earlier version of the manuscript. This research was supported, in part, by National Science Foundation Grant BSR-0818399, and we thank Fabian A. Michelangeli for his administrative and professional assistance in connection with this grant-supported project.

REFERENCES

Alain, Bro. 1946. Notas taxonomicas y ecologicas sobre la flora de Isla de Pinos. Contr. Ocas. Mus. Hist. Nat. Col. De La Selle. No. 7. Havana, Cuba.

Alain, Bro. (= A. H. Liogier). 1957. Flora de Cuba. Vol. 4. Dicotiledóneas: Melastomataceae a Plantaginaceae. Cont. Ocas. Mus. Hist. Nat. Col. "De La Salle." Havana, Cuba.

Alexander, T.R. 1967. A tropical hammock on the Miami (Florida) limestone—A twenty-five-year study. Ecology 48:863–867.

Barker, H.D. & W.S. Dardeau. 1930. La flora d'Haiti. Service Technique de Département de l'Agriculture et de l'Enseignement Professionnel, Port-au-Prince, Haiti.

Bécquer-Granados, E.R., K.M. Neubig, W.S. Judd, F.A. Michelangeli, J.R. Abbott, & D.S. Penneys. 2008. Preliminary molecular phylogenetic studies in *Pachyanthus* (Miconieae, Melastomataceae). Bot. Rev. 74:37–52.

Bentham, G. 1846. *Diplochita angustiflora*. Plantas Hartwegianae. London, U.K. Pp. 263–264.

Berazaín, R. 1987. Notas sobre vegetación y flora de la Sierra de Cajálbana y Sierra Preluda (Pinar del Río). Revista Jard. Bot. Nac. Univ. Habana 8:39–68.

Berazaín, R., F.A. Berazaín, J.C. Lazcano, & L.R. González. 2005. Lista roja de la flora vascular Cubana. Documentos del Jard. Bot. Atlántica (Gijón) 4:1–86.

Borhidi, A. 1977 [1978]. *Tetrazygiopsis*, género nuevo de las Antillas y el género *Tetrazygia* L.C. Rich. (Melastomataceae) en Cuba. Acta Bot. Hung. 29:181–215.

Borhidi, A. 1991. Phytogeography and vegetation ecology of Cuba. Akadémiai Kiadó, Budapest, Hungary.

Borhidi, A. & Muñiz. 1983. Catalogo de plantas cubanas amenazads o extinguidas. Academia de Ciencias de Cuba, la Habana, Cuba.

Borhidi, A. & Muñiz. 1986. The phytogeographic survey of Cuba. II. Floristic relationships and phytogeographic subdivision. Acta Bot. Hung. 32:3–48.

Britton, N.L. & P. Wilson. 1920. *Calycogonium saxicola*. Mem. Torrey Bot. Club 16:91–92.

Carabia, J.P. 1945. The vegetation of Sierra de Nipe, Cuba. Ecol. Monog. 15:322–341

Ciferri, R. 1936. Studio geobotánico dell'isola Hispaniola (Antille). Atti Ist. Bot. Univ. Pavia 8:1–336.

Cogniaux, A. 1891. Melastomataceae. In: A. de Candolle & C. de Candolle, eds. Monographiae phanerogamarum. 7. Masson, Paris. Pp. 1–1256.

Coker, W.C. 1905. Vegetation of the Bahama Islands. Johns Hopkins Press, MacMillan and Co., New York, U.S.A.

Correll, D.S. & H.B. Correll. 1982. Flora of the Bahama Archipelago: Including the Turks and Caicos Islands. Lubrecht & Cramer, Ltd, New York, U.S.A.

De La Sagra, R. 1850. Historia fisica, politica y natural de la Isla de Cuba. *Naudinia argyrophylla*. A. Bertrand, Paris, France. Vol. 12. t. 44(1).

García, R. & M. Mejía. 2008. Vegetacion y flora de serpentine de la Republica Dominicana. Moscosoa 16:217–253.

Gleason, H.A. 1925. Studies on the flora of northern South America. VI. Bull. Torrey Bot. Club 52:325–340.

Gleason, H.A. 1932. A synopsis of the Melastomataceae of British Guiana. Brittonia 1:127–184.

Gleason, H.A. 1958. Melastomataceae. In: R.E. Woodson, Jr. & R.W. Schery, eds. Flora of Panama. Ann. Missouri Bot. Gard. 45:203–304.

Goldenberg, R., D.S. Penneys, F. Almeda, W.S. Judd, & F.A. Michelangeli. 2008. Phylogeny of *Miconia* (Melastomataceae): Patterns of stamen diversification in a megadiverse Neotropical genus. Int. J. Pl. Sci. 169:963–979.

Goldenberg, R., F. Almeda, M. K. Caddah, A. B. Martius, J. Meirelles, F. A. Michelangeli, & M. Weiss. 2013. Nomenclatur botanicus for the neotropical genus *Miconia* (Melastomataceae: Miconieae). Phytotaxa 106:1–171.

Hager, J. & T.A. Zanoni. 1993. La vegetación natural de la República Dominicana: Una nueva clasificación. Moscosoa 7:39–81.

Haynes, J., J. McLaughlin, L. Vasquez, & A. Hunsberger. 2001. Low-maintenance landscape plants for South Florida. Environmental Horticulture Dept., Florida Cooperative Extension Service, University of Florida-IFAS Publication ENH854, Florida, U.S.A.

Ionta, G.M., W.S. Judd, J.D. Skean, Jr., & C.K. McMullen. 2012. Two new species of *Miconia* sect. *Sagraea* (Melastomataceae) from the Macaya Biosphere Reserve, Haiti, and twelve relevant new species combinations. Brittonia 64:61–72.

Ionta, G.M. & W.S. Judd. 2012. *Miconia cordieri*, a new species of *Miconia* sect. *Sagraea* (Melastomataceae) from the Macaya Biosphere Reserve, Haiti. J. Bot. Res. Inst. Texas 6:37–44.

Judd, W.S. 1986. Taxonomic studies in the Miconieae (Melastomataceae). I. Variation in inflorescence position. Brittonia 38:150–161.

Judd, W.S. 1989. Taxonomic studies in the Miconieae (Melastomataceae). III. Cladistic analysis of axillary-flowered taxa. Ann. Missouri Bot. Gard. 76:476–495.

Judd, W.S. 2007. Revision of *Miconia* sect. *Chaenopleura* (Miconieae, Melastomataceae) in the Greater Antilles. Syst. Bot. Monogr. 81:1–235.

Judd, W.S. & J.D. Skean, Jr. 1991. Taxonomic studies in the Miconieae (Melastomataceae). IV. Generic realignments among terminal-flowered taxa. Bull. Florida Mus. Nat. Hist., Biol. Sci. 36:25–84.

Judd, W.S., J.R. Abbott, & A. Morris. 2008. *Illicium guajaibonense*, elevated to species rank and compared with the subspecies of *Illicium cubense* (Illiciaceae). J. Bot. Res. Inst. Texas 2:799–806.

Judd, W.S. & G.M. Ionta. 2013. Taxonomic studies in the Miconieae (Melastomataceae). X. Revision of the species of the *Miconia crotonifolia* complex. Brittonia 65:66–95.

Judd, W.S., E.R. Bécquer, & L.C. Majure. 2014. Taxonomic studies in the Miconieae (Melastomataceae). XI. A revisión of *Miconia* sect. *Calycopteris* on Hispaniola. Brittonia 66:216–249. DOI 10.1007/sl12228-014-9326-4.

Liogier, A.H. 2000. La flora de la Española. Vol. IX. Melastomataceae. Jardín Botánico Nacional "Dr. Rafael Ma. Moscoso" Instituto Tecnológico de Santo Domingo, Santo Domingo, República Dominicana.

Long, R.W. & O. Lakela. 1978. A flora of tropical Florida. Banyan Books, Miami, Florida, U.S.A.

Lorenzo, J.S., B. Peguero, & A. Veloz. 1997. Flora de la Peninsula de Samaná, República Dominicana. Moscosoa 9:133–188.

MacBride, J. F. 1941. Melastomataceae. Flora of Peru. Fieldiana, Bot. 13:249–523.

Majure, L.C. & W.S. Judd. 2012. *Miconia phrynosomaderma* (Melastomataceae: Miconieae), a new species from the Massif du Nord, Haiti, and sixteen new names and combinations. J. Bot. Res. Inst. Texas 7:265–274.

Majure, L.C., W.S. Judd, G.M. Ionta, J.D. Skean, Jr., K.M. Neubig, & E. Bécquer-Granados. 2014. *Miconia cineana*, a new species from the Massif de la Hotte, Haiti, based on morphological and molecular evidence. Syst. Bot. 39:906–914.

Martin, C.V., D. Little, R. Goldenberg, & F.A. Michelangeli. 2008. A preliminary phylogenetic analysis of the polyphyletic genus *Leandra* (Miconieae, Melastomataceae). Cladistics 24:315–327.

Meerow, A.W. 1991. Native shrubs for South Florida. University of Florida-IFAS Publication EES-59, Florida, U.S.A.

Mejía, M., J. Pimentel, & R. García. 2011. Árboles y arbustos de la región cársica de Los Haitises, República Dominicana. Moscosoa 17:90–114.

Michelangeli, F.A., W.S. Judd, D.S. Penneys, J.D. Skean, Jr., E.R. Bécquer, R. Goldenberg, & C.V. Martin. 2008. Multiple events of dispersal and radiation of the tribe Miconieae (Melastomataceae) in the Caribbean. Bot. Rev. 74:53–77.

Michelangeli, F.A. & E.R. Bécquer. 2012. Melastomataceae. In: P. Acevedo-Rodríguez & M. T. Strong. Catalogue of seed plants of the West Indies. Smithsonian Contr. Bot. No. 98. Smithsonian Institution Scholarly Press, Washington, D.C., U.S.A. Pp. 531–652.

Miller, P. 1768. 6. *Melastoma bicolor*. Gardeners dictionary, ed. 8. London, U.K.

Morejón, R. & C. Sánchez. 2012. Novelties in the fern genus *Polystichum* (Dryopteridaceae): Three new taxa for Cuba. Willdenowia 42:273–281.

Moscoso, R.M. 1943. Catalogus florae domingensis. Parte 1. Spermatophyta. Universidad de Santo Domingo, Santo Domingo, Dominican Republic.

Myers, R.L. & J.J. Ewel. 1990. Ecosystems of Florida. University of Central Florida Press, Orlando, Florida, U.S.A.

Naudin, C. 1850. *Miconiastrum lambertianum*. Melastomacearum quae in musaeo Parisiensi continentur monographicae descriptionis. Ann. Sci. Nat., Bot. sér. 3, 15:341–342.

Nelson, G. 2011. The trees of Florida, 2nd ed. Pineapple Press, Sarasota, Florida, U.S.A.

Nickrent, D.L., W.H. Eshbaugh, & T.K. Wilson. 2008. Vascular flora of Andros Island, Bahamas. http://plant.siu.edu/Faculty/nickrent/NickrentPDFs/AndrosFloraSm.pdf.

Olmsted, I., W.B. Robertson, Jr., J. Johnson, & O.L. Bass, Jr. 1983. The vegetation of Long Pine Key, Everglades National Park.

Report SFRC-83/05. National Park Service, South Florida Research Center, Everglades National Park, Homestead, Florida, U.S.A.

Osorio, R. 1991. Three pine rock land shrubs. Palmetto 11:8–9.

Penneys, D.S. & W.S. Judd. 2003. The resurrection and lectotypifications of *Tetrazygia fadyenii* (Melastomataceae: Miconieae): A hummingbird-pollinated treelet endemic to Jamaica. Sida 20:877–884.

Penneys, D.S. & W.S. Judd. 2005. A systematic revision and cladistic analysis of *Charianthus* (Melastomataceae) using morphological and molecular characters. Syst. Bot. 30:559–584.

Phillips, W.S. 1940. A tropical hammock on the Miami (Florida) limestone. Ecology 21:166–175.

Proctor, G.R. 1972. Melastomataceae. In: C.D. Adams. Flowering plants of Jamaica. University of the West Indies, Mona, Jamaica. Pp. 529–548.

Regalado, L., I. Ventosa, & R. Morejón. 2008 [2010]. Revisión histórica de los herbarios cubanos con énfasis en las series de especímenes. Revista Jard. Bot. Nac. Univ. Habana 29:101–138.

Sargent, C.S. & C.E. Faxon. 1911. Trees and shrubs: Illustrations of new or little known ligneous plants. Vol. 2., Part 3. Houghton, Mifflin & Co., Boston & New York. [*Tetrazygia bicolor*: pp. 171–173, Pl. CLXX.]

Seifriz, W. 1943. The plant life of Cuba. Ecol. Monogr. 13:375–426.

Small, J.K. 1905. Additions to the flora of subtropical Florida. Bull. New York Bot. Gard. 3:419–440.

Small, J.K. 1913. Florida trees. Publ. by the author, New York, U.S.A.

Smith, E.E. 1954. The forests of Cuba. Maria Moors Cabot Foundation Publ. 2:1–98.

Smith, I.K., W.H. Esbaugh, J.L. Vankat, & T.K. Wilson. 1992. On the nature of the dry evergreen forest (coppice) communities of North Andros Island, Bahamas. In: W.H. Esbaugh, ed. Proceedings of the fourth symposium of the natural history of the Bahamas. Bahamian Field Station, Ltd. San Salvador, Bahamas. Pp. 109–123.

Solt, M.L. & J.J. Wurdack. 1980. Chromosome number in the Melastomataceae. Phytologia 47:199–220.

Sprengel, K. 1822. *Melastoma pallens*. Neue Entdeckungen im ganzen Umfang der Pflanzenkunde 3:62.

Thiers, B.M. 2012. [continuously updated]. Index Herbariorum: A global directory of public herbaria and associated staff. New York Botanical Garden's Virtual Herbarium. http://sweetgum.nybg.org./ih/

Urban, I. 1920–21. Melastomataceae. Flora domingensis. Symbolae antillanae 8:490–505.

Urban, I. 1926. *Tetrazygia lanceolata, T. minor, T. versicolor, T. coriacea, T. impressa*. Sertum antillanum XXVI. Repert. Spec. Nov. Regni Veg. 22:223–225.

Vázquez, L., R. González, R. Berazaín, & E. Bécquer. 2006. Flora de la region ultramáfica (serpentinícola) de Guamuhaya. Revista Jard. Bot. Nac. Univ. Habana 27:75–84.

Wagner, W.L., D.R. Herbst, & S.H. Sohmer. 1990. Manual of the flowering plants of Hawai'i, vol. 1. University of Hawaii, Bishop Museum Press, Honolulu, Hawaii, U.S.A.

Weaver, R.E. and P.J. Anderson. 2010. Notes on Florida's endangered and threatened plants. 5th ed. Bureau of Entomology, Nematology & Plant Pathology–Botany Section. Contr. No. 38. Division of Plant Industry, Gainesville, Florida, U.S.A.

West, E. & L.E. Arnold. 1956. The native trees of Florida, revised ed. University of Florida Press, Gainesville, Florida, U.S.A.

Wheeler, Q.D. & N.I. Platnick. 2000. The phylogenetic species concept (*sensu* Wheeler and Platnick). In: Q.D. Wheeler & R. Meier, eds. Species concepts and phylogenetic theory: A debate. Columbia University Press, New York, U.S.A. Pp. 55–69.

Wunderlin, R.P. & B.F. Hansen. 2011. Guide to the vascular plants of Florida, 3rd ed. University Press of Florida, Gainesville, Florida, U.S.A.

Wurdack, J.J. 1972. Certamen Melastomataceis XVIII. Phytologia 22:399–418.

Wurdack, J.J. 1980. Melastomataceae. In: G.H. Harling & B. Sparre, eds. Flora of Ecuador, No. 13. Univ. Göteborg & Riksmuseum, Stockholm, Sweden. Pp. 1–406.

Wurdack, J.J. 1986. Atlas of hairs for Neotropical Melastomataceae. Smithsonian Contr. Bot. No. 63. Smithsonian Institution Press, Washington, D.C., U.S.A.

Wurdack, J.J. & R. Kral. 1982. The genera of Melastomataceae in the southeastern United States. J. Arnold Arbor. 63:429–439.

Zanoni, T.A., M.M. Mejía, J.D. Pimentel, & R.G. García. 1990. La flora y la vegetación de Los Haitises, República Dominicana. Moscosoa 6:46–98.

BOOK REVIEW

Peter Wyse Jackson. 2014. **Ireland's Generous Nature: The Past and Present Uses of Wild Plants in Ireland.** (ISBN-13: 978-0915279784, hbk). Missouri Botanical Garden Press, P.O. Box 299, St. Louis, Missouri 63166-0299, U.S.A. (**Orders:** www.mbgpress.org). $60.00 (leather bound $75.00), 768 pp., color photos and illustrations, 8.25" × 10.25".

This comprehensive study of the ethnobotany of Ireland provides an in-depth, interesting, and enjoyable discussion of the historic and current uses, as well as the cultural significance, of native and introduced plants that are found throughout the Irish countryside.

At 750 pages, this volume contains information on more than 1000 species of plants, of which more than 600 have known ethnobotanical uses. The first 150 pages of the book provide the reader with historical and cultural context as well as general information related to the plants. The remainder of the book is devoted to an alphabetical listing, narrative descriptions, and common uses of flowering plants, grasses and sedges, trees and shrubs, ferns and fern allies, algae, and miscellaneous plants.

The narrative on each species includes facts, lore, legend, and traditions associated with that plant. There are 17 categories of ethnobotanical uses, all represented by icons. The icons are displayed along with the narrative descriptions for quick reference. Many of the descriptions are also accompanied by a small color photo of the plant. Ethnobotanical uses such as plants used for food, beverages, medicines, potions, cosmetics, textiles, construction materials, arts and crafts, dyes, poisons, cultural and religious symbols, currency, and many other uses are noted as appropriate for each species.

The first appendix is a listing of plant names that are part of local Irish place names. Appendix II is a listing of plants with the scientific plant name, the Irish common name, and the Gaelic name (with pronunciation guides!) for each plant. These listings are followed by a section which describes the exhibitions and traditional folklife locales where plants and their varied uses can be seen and studied. Finally, there is a glossary which is useful in understanding the botanical and taxonomic terminology that is commonly used in Ireland.

This unique book would be enjoyable and useful to botanists as well as casual readers who have a special interest in ethnobotany, the natural resources of Ireland, or the social and cultural history of Ireland.—*Dan Caudle, Independent Grassland Consultant, Weatherford, Texas, U.S.A.*

CALATHEA RUBRIBRACTEATA, A NEW ENDEMIC SPECIES OF MARANTACEAE FROM COLOMBIA

Helen Kennedy

UCR Herbarium, Department of Botany and Plant Science
University of California Riverside
Riverside, California 92521, U.S.A.
ganders@mail.ubc.ca

ABSTRACT

Calathea rubribracteata H. Kenn. endemic to Dept. Valle de Cauca, Colombia, is described as new. It is similar in aspect to the Ecuadorian species *C. neillii* H. Kenn., *C. fredii* H. Kenn., *C. cofaniorum* H. Kenn. and *C. shishicoensis* H. Kenn. and to the Colombian species *C. trianae* L.B. Sm. & Idrobo and *C. timothei* H. Kenn. with several basal leaves and a single cauline leaf or bladeless sheath subtending an inflorescence of bright red or rose-pink bracts. *Calathea rubribracteata* differs from *C. trianae, C. neillii,* and *C. fredii* in the spirally arranged vs. distichous bracts and relatively wider leaf blades (length:width ratios 3.03–3.58:1 vs. 3.55–7.45), from *C. timothei* by the fewer bracts (6–11 vs. 40–ca. 100) and the usually 3 vs. 7 minor veins between the major veins and from *C. shishicoensis* by the relatively narrower leaf blades (length:width ratios 3.03–3.58:1 vs. 1.33–1.75:1) and yellow vs. pale pink flowers.

RESUMEN

Calathea rubribracteata H. Kenn. endémica del Depto. de Valle de Cauca, Colombia, es descrita como nueva especie. Ella es similar en aspecto a las especies *C. neillii* H. Kenn., *C. fredii* H. Kenn., *C. cofaniorum* H. Kenn. y *C. shishicoensis* H. Kenn. de Ecuador y *C. trianae* L.B. Sm. & Idrobo y *C. timothei* H. Kenn. de Colombia que tienen varias hojas basales y solo una hoja caulinar o una vaina sin lámina foliar que subtiende una inflorescencia con brácteas rojas o rosadas brillantes. *Calathea rubribracteata* se distingue de *C. trianae, C. neillii* y *C. fredii* por sus inflorescencias con brácteas espiraladas vs. dísticas y las hojas relativamente más anchas (la relación largo/ancho es 3.03–3.58:1 vs. 3.55–7.45), de *C. timothei* por las pocas brácteas (6–11 vs. 40–ca. 100) y con la lámina foliar que lleva generalmente 3 vs. 7 venas menores entre las venas mayores, y de *C. shishicoensis* por las hojas relativamente más estrechas (la relación largo/ancho es 3.03–3.58:1 vs. 1.33–1.75:1) y las flores amarillas vs. rosado pálidas.

Both Colombia and Ecuador have a rich diversity of Marantaceae. Collecting in the montane forests in both countries have yielded some interesting new, red-bracted species of *Calathea*. There are currently 69 species of *Calathea* recognized for Ecuador (Kennedy 2013, 2014), but so far only 49 described species are recorded for Colombia. With such diversity and additional collections and herbarium work, the number should soon equal that for Ecuador as at least ten more species are known but as yet undescribed, including the one herein. As with *C.trianae* and *C. timothei* from Colombia, and *C. neilli*, *C. fredii*, *C. cofaniorum* and *C. shishicoensis* from Ecuador, this new species, with its attractive bright red bracts, would make an excellent ornamental species.

TAXONOMIC TREATMENT

Calathea rubribracteata H. Kenn., sp. nov. (**Fig. 1**). TYPE: COLOMBIA. VALLE DEL CAUCA: Km 18 y Km 20 de la carretera de Cali a Buenaventura entrando por la finca Zingara, cumbre de la cordillera occidental, selva clímax andina, nublada y húmeda con abundante capote, relictus de las selva nublada y bastante intervenida antropogénicamente, 1500–2000 m, 03°28'N, 76°35'W, 28 Feb 1988, *I. Cabrera & H. van der Werff 15829* (HOLOTYPE: MO 3765450).

Haec species a *Calathea neillii* H. Kenn., *C. fredii* H. Kenn. et *C. cofaniorum* H. Kenn. bracteis spiraliter dispositis (vs. distichis) atque lamina foliari pro ratione latiore (longitudinis cum latitudine proportione 3.03–3.58 vs. 4.80–7.45), a *C. trianae* L.B. Sm. & Idrobo inflorescentia turbinata (vs. rectangulari; longitudinis cum latitudine proportione ca. 1.2 vs. 6.00–7.33), a *C. timothei* H. Kenn. bracteis paucioribus (6 ad 11 vs. 40 ad ca. 100) atque venis minoribus plerumque 3 (vs. 7) inter majores, a *C. shishicoensi* H. Kenn. lamina foliari pro ratione angustiore (longitudinis cum latitudine proportione 3.03–3.58 vs. 1.33–1.75) atque floribus flavis (vs. pallide roseis) differt.

Plants rhizomatous, caulescent, herbs, 35–60 cm high; stem green, internodes between basal leaves sericeous, uppermost, elongate, portion glabrous; cataphylls appressed tomentose, more densely so at apex, margins and

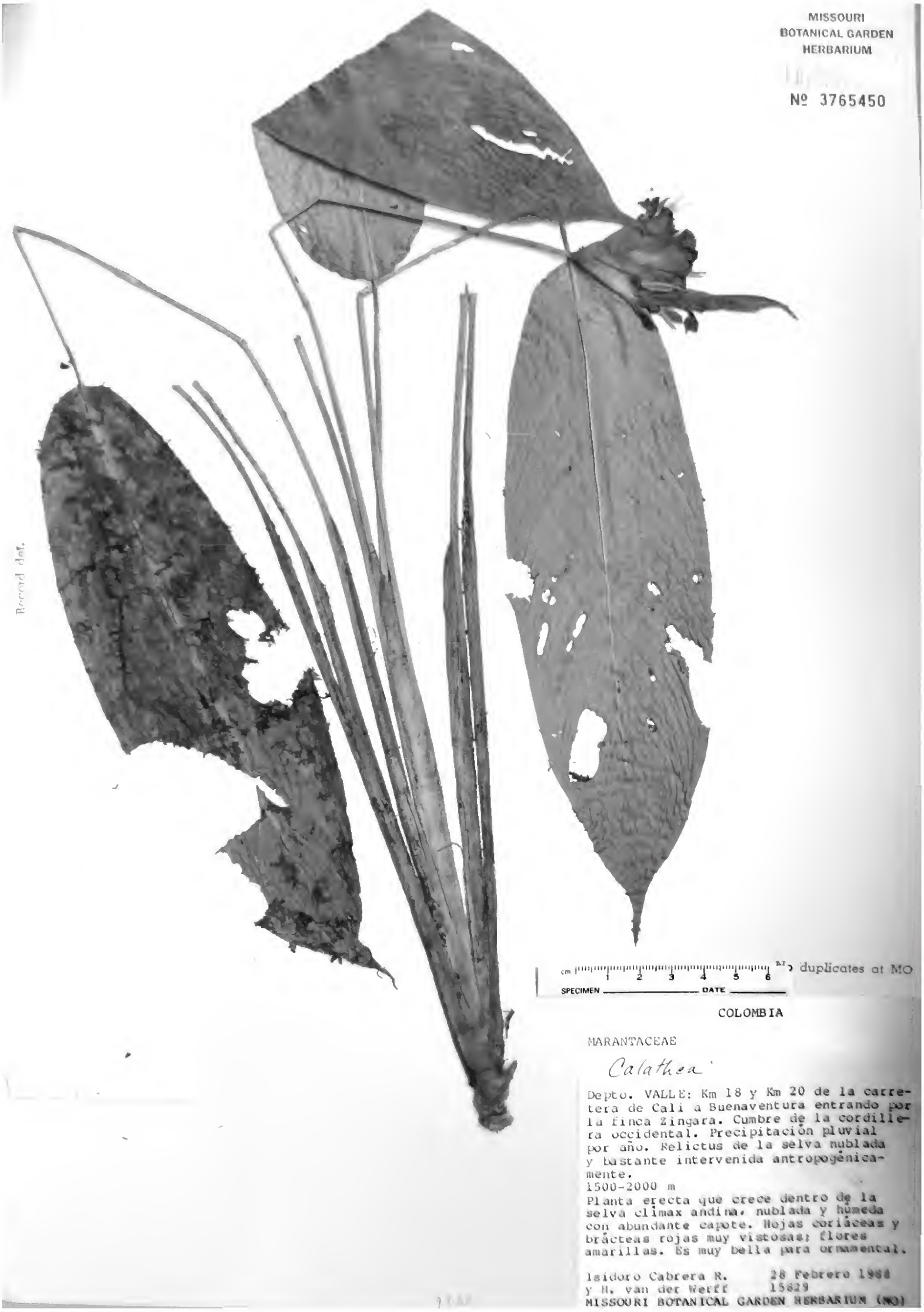


Fig. 1. *Calathea rubribracteata* H. Kenn. Holotype. (*I. Cabrera & H. van der Werff 15829* MO).

base. **Leaves** 4–8 basal, none or 1 cauline, a cauline leaf or bladeless sheath borne atop a ca. 36 cm stem internode; leaf sheath not auriculate, green, wings lighter, tinged reddish, apical 1 cm subglabrous, appressed tomentose basally, the hairs more dense and longer toward the base, the hairs 0.25–1 mm, 13–17.5 cm; petiole green, tomentose in a band adaxially in apical 3–4 cm, glabrous basally, bearing a shallow groove apically, 9–23.5 cm; pulvinus articulate, noticeably thicker than petiole, olive-green or tinged with red, tomentose in a narrow band adaxially, the hairs 0.2–0.3 mm, the rest glabrous, 1–2.6 cm; leaf blade coriaceous, elliptic, apex acuminate-attenuate, base obtuse to rounded, 18.2–23.5 × 5.7–7 cm (lenght:width ratios 3.03–3.58:1), generally 3 minor veins between major veins, vein angle of divergence from midrib (measured at midpoint of blade) 34°–43°, 13–15 veins per 3 cm, 22–27 veinlets per 5 mm (measured at midpoint of each side of the blade), adaxial leaf surface deep green, glabrous except appressed tomentose on blade in apical 2 cm, more densely so toward apex, midrib yellowish green, minutely tomentose, the hairs faint straw-colored, 0.25 mm; abaxial leaf surface grey-green, glabrous except tuft of hairs on apicalmost 2–3 mm, midrib yellow-green, essentially glabrous except for a few sparse colorless hairs along sides in basal half, the hairs to 0.2 mm (seen at 30× magnification). **Inflorescence** terminal, 1 or 2 per shoot, first borne terminally the second in the axil of the subtending leaf or bladeless sheath, lax, turbinate, ca. 4 × 3.3 cm; peduncle red, glabrous, ca. 1 cm. **Bracts** 6–11, spirally arranged, lowermost one elliptic, upper ones broadly elliptic to broadly obovate, apex obtuse, margin and apex spreading, 2.2–2.5 × 1.6–2 cm, abaxial surface of bracts red, sericeous at very base, sparely pilose along basal margin, the hairs 0.3 mm, adaxial surface red, glabrous, rachis sericeous; bicarinate prophyll membranous, obovate, apex obtuse, red apically, sparsely scattered pilose on distal surface of the basal half of the carina, the hairs 0.7–1 mm, ca. 2.1 × 0.65 cm, ca. 0.5 cm carina to carina; secondary bract membranous, narrowly elliptic, apex obtuse, glabrous, 1.8–1.95 × 0.5–0.65 cm; bracteoles 2 per flower pair, membraneous, medial, one carinate, one channeled, narrowly elliptic, acute, glabrous, 1.55–1.7 × 0.2–0.3 cm. **Flowers** opening spontaneously, but only partially open as the petals, though separated, do not reflex. **Sepals** narrowly oblong-elliptic, obtuse, yellow apically, cream below, glabrous, 14.5–17 × 2.5–3 mm. **Corolla** yellow, glabrous, tube 16–18 mm; corolla lobes subequal, elliptic, obtuse, margins inrolled, 8.5–9 × 3.5–4.5 mm. **Staminodes** yellow; outer staminode not found in material available; callose staminode totally callose, spathulate, apex rounded to shallowly retuse, ca. 8 × 5–5.5 mm; cucullate staminode 5–5.5 mm; stamen yellow with lateral petaloid appendage to 1.5 mm wide, extending half way along the anther, anther 2 mm; style and stigma yellow, stigma blunted. **Ovary** ca. 1.5 × 1 mm. **Capsule** unknown.

Distribution and habitat.—*Calathea rubribracteata* is endemic to Colombia, known from the type locality in the Department of Valle de Cauca, in the Cordillera Occidental, and in cultivation in a nearby, private garden, at ca. Km 22 on the Cali to Buenaventura road. It occurs at 1500–2000 m elevation in a relictual climax Andean cloud forest. The type was collected in flower in February.

Discussion.—*Calathea rubribracteata* shares the general habit of several basal leaves with an inflorescence of bright red or rose-pink bracts borne above an elongate stem internode with *C. fredii, C. neillii*, *C. cofaniorum,* and *C. shishicoensis* from Ecuador and *C. trianae* and *C. timothei* from Colombia. It differs from *C. trianae*, *C. neillii, C. fredii,* and *C. cofaniorum* in the spirally arranged vs. distichous bracts and relatively wider leave blade (length:width ratios 3.03–3.58:1 vs. 3.55–7.45), from *C. timothei* by the fewer bracts (6–11 vs. 40–ca. 100) and the usually 3 vs. 7 minor veins between the major veins, and from *C. shishicoensis* by the relatively narrower leaf blade (length:width ratios 3.03–3.58:1 vs. 1.33–1.75:1) and yellow vs. pale pink flowers. It is interesting to note that *C. timothei* lacks the outer staminode and has a blunted stigma (Kennedy 1977). Whether *C. rubribracteata* in fact also lacks the outer staminode was not clear from the material at hand, but it appeared to have a similar blunted stigma and also the non-reflexed petals. Many of these red to rose-pink bracted species are found in the upper altitudes for Marantaceae distribution, 800–2100 m, in premontane to montane cloud forest habitats.

Etymology.—The specific epithet, *rubribracteata,* refers to its bright red bracts.

ACKNOWLEDGMENTS

The Missouri Botanical Garden provided support for my accommodations while working in the MO herbarium (organized, thanks to Olga Martha Montiel). Fred Ganders covered the travel expenses for the trips to MO and UCR. I thank Isidoro Cabrera R. and Henk van de Werff for collecting *C. rubribracteata*. I am grateful to Andrew Sanders for providing facilities at the UCR herbarium, to Teresa Salvado for providing accommodations and transportation in Riverside and to James Solomon for the loan material from MO. I thank Carla Black and Emilio Constantino for sharing their color photos of the plant. I thank Luz Stella Suárez S., Barney Lipscomb, and anonymous reviewer for helpful suggestions and corrections. Roy Gereau provided the Latin diagnosis.

REFERENCES

Kennedy, H. 1977. Unusual floral morphology in a high altitude *Calathea* (Marantaceae). Brenesia 12/13:1–9.

Kennedy, H. 2013. Two new endemic species of *Calathea* (Marantaceae) from Ecuador. J. Bot. Res. Inst. Texas 7(1):161–167.

Kennedy, H. 2014. *Calathea cofaniorum* and *C. shishicoensis*, new endemic species of Marantaceae from Ecuador. J. Bot. Res. Inst. Texas 8(1):37–42.

FIVE NEW MYRTACEAE FROM SOUTHEASTERN BRAZIL

Marcos Sobral
DCNAT - UFSJ
São João del-Rei, MG, BRAZIL
marcos_sobral@hotmail.com

Marcelo da Costa Souza
Dep. Botânica - UFRRJ
Seropédica, RJ, BRAZIL
souza.m@gmail.com

Ludovic Jean Charles Kollmann
Museu de Biologia Mello Leitão
Santa Teresa, ES, BRAZIL
ludovic@limainfo.com.br

Osny Tadeu Aguiar
Instituto Florestal de São Paulo
São Paulo, SP, BRAZIL
tadeu@iflorestal.sp.gov.br

André Luís Casarin Rochelle
Dep. Botânica - Unicamp
Campinas, SP, BRAZIL
rochelle@unicamp.br

Kelly Antunes
Dep. Botânica - Museu Nacional
Rio de Janeiro, RJ, BRAZIL
klybio@yahoo.com.br

ABSTRACT

We here describe, illustrate, and evaluate the conservation status of five new species from southeastern Brazil: **Calyptranthes solitaria, C. ubatubana, Eugenia dipetala, Myrcia cacuminis,** and **Plinia ambivalens.** *Calyptranthes solitaria,* collected in the states of Minas Gerais, Rio de Janeiro, and São Paulo, is apparently related to *Calyptranthes tricona,* from which it is kept apart by the uniflorous inflorescences and glabrous adult leaves. *Calyptranthes ubatubana* is apparently restricted to the state of São Paulo and is related to *Calyptranthes lanceolata,* from which it is distinguished by its pilose inflorescences and flowers. *Eugenia dipetala* and Myrcia cacuminis are from the state of Espírito Santo. *Eugenia dipetala* is distinguished from other Brazilian species by flowers showing two petals; *Myrcia cacuminis* is related to *M. capitata,* from which it is distinguished by the petiolate leaves, lanceolate blades, and triflorous inflorescences. *Plinia ambivalens,* from Espírito Santo and Bahia, is related to *Plinia involucrata,* from which it differs by the leaves with larger petioles, venose blades, and ovaries with multiovulate locules.

Key Words: Mata Atlântica, *Calyptranthes, Eugenia, Myrcia, Plinia*

RESUMO

São descritas, ilustradas e avaliadas quanto à sua conservação **Calyptranthes solitaria, C. ubatubana, Eugenia dipetala, Myrcia cacuminis** e **Plinia ambivalens.** *Calyptranthes solitaria*, coletada nos estados de Minas Gerais, Rio de Janeiro e São Paulo, é aparentemente próxima de *Calyptranthes tricona*, diferindo pelas inflorescências unifloras e folhas adultas glabras. *Calyptranthes ubatubana*, aparentemente restrita ao estado de São Paulo, é próxima de *C. lanceolata*, diferindo pelas inflorescências e flores pilosas. *Eugenia dipetala* e *Myrcia cacuminis* ocorrem no estado do Espírito Santo. *Eugenia dipetala* difere de todas as espécies brasileiras pela presença de duas pétalas; *Myrcia cacuminis* é próxima de *Myrcia capitata*, diferindo pelas folhas pecioladas, lâminas lanceoladas e inflorescências trifloras. *Plinia ambivalens*, dos estados da Bahia e Espírito Santo, é próxima de *Plinia involucrata*, diferindo pelas folhas com pecíolos mais longos, lâminas com venação evidente e ovários com lóculos multiovulados.

Key Words: Mata Atlântica, *Calyptranthes, Eugenia, Myrcia, Plinia*

INTRODUCTION

Myrtaceae comprise 22 native genera and about 990 species in Brazil (Sobral et al. 2014), from which about 680 grow in the coastal Brazilian Atlantic rainforest, which extends about 5,000 km from northeastern to southern Brazil (Silva & Casteleti 2005), embracing a considerable part of Brazilian biological diversity and being considered by Myers et al. (2000) as one of the diversity hotspots worldwide. However, because it has been subject to such intense anthropogenic pressures such as urban expansion, farming, mining and legal or illegal logging that reduced its cover to less than 10% of its original extent (Galindo-Leal & Câmara 2005). Nevertheless, its diversity is still poorly surveyed, and intensive collection efforts in this biome frequently bring to light several undescribed and in some cases extremely local species. The examination of recent collections from southeast-

ern Brazil have revealed to us some species that we consider as new, which are described here. For the evaluation of their conservation status, we used the conservation criteria proposed by IUCN (2012). In order to get an estimate of the collection efforts in the municipalities cited in this paper, we compared the available data on collection numbers (CRIA 2014) and the total area (IBGE 2014) of each municipality; although not especially informative for conservation issues, this estimate can be interesting, since the scarcity of specimens from a well surveyed location may suggest a real rareness of one species. For this, we consider as moderately surveyed areas those with more than three gatherings/km² (an index proposed by Shepherd 2003); since the average of gatherings in Brazil is smaller than one collection/km² (Sobral & Stehmann 2009), the Shepherd index may serve as a good parameter for the intensity of botanical survey.

NEW SPECIES

Calyptranthes solitaria Sobral, Aguiar, & Antunes, sp. nov. (**Figs. 1–2**). TYPE: BRAZIL. SÃO PAULO: Mun. Salesópolis, Parque Estadual da Serra do Mar, trilha da Torre, 23 Feb 2005, *F.M. Souza, M.T.Z. Toniato & D. Souza 495* (HOLOTYPE: SPSF; ISOTYPE: HUFSJ).

This species is apparently related to *Calyptranthes tricona,* differing through its coriaceous blades that easily fracture when bent (versus chartaceous blades, bending without fracturing), which are mostly glabrous abaxially when adult (vs. visibly pilose), its uniflorous inflorescences with bracts, if present, deciduous early before anthesis (vs. triflorous inflorescences with lanceolate bracts subtending the flowers and frequently persisting through anthesis) and flowers with one or two petals (vs. petals absent).

Tree 2–14 m high. Twigs terete, dichotomously branched, the young ones velutinous, with simple brown trichomes to 2 mm, the older ones entirely glabrous, the young cortex exfoliating, in some internodes tearing longitudinally and falling as one entire piece; internodes 25–40 × 1–2.5 mm, the nodes slightly swollen and with circular scars due to the exfoliation of the cortex, more visible at the proximal side of the node. Leaves with petioles 4–10 × 1–2 mm, glabrous; blades elliptic, narrowly elliptic or ovate, 40–90 × 16–35 mm, 1.7–2.8 times longer than wide, coriaceous when adult, the young ones markedly discolorous, green and with scattered simple trichomes to 0.5 mm adaxially, brown and densely covered with an arachnoid indumentum of curled simple trichomes 0.5–1 mm, along with some scattered straight simple trichomes to 2 mm, mature leaves glabrous or with very scattered trichomes on the abaxial surface, slightly discolorous, the adaxial side green or dark brown and with the venation very delicately sulcate, the abaxial surface light, dull green, with glandular dots about 0.1 mm in diameter, ca. 5/mm², visible only when examined against light; apex acuminate, 2–8 mm; base cuneate; midvein moderately sulcate adaxially and prominent abaxially; lateral veins 10 to 18 at each side, plane or finely sulcate adaxially, moderately prominent abaxially, departing from the midvein at 45–60°; marginal vein 1–2 mm, occasionally a second vein visible at 0.2–0.3 mm from the margin, the margin itself revolute and with a pale yellow thickening 0.1–0.2 mm wide. Inflorescences uniflorous, axillary, one or two per axil, the pedicel 20–25 × 1–1.5 mm, with a dense indumentum of simple brown erect or ascending trichomes to 1 mm; bracts not seen, possibly early deciduous; bracteoles not seen, apparently deciduous before anthesis due to evident scars at the base of the flowers; flower buds ovate, 6–8 × 4 mm, densely covered with trichomes as the inflorescences, with an evident apiculum to 1 mm, opening through a calyptra to 1 × 4 mm, glabrous internally; petals one or two, rounded, to 1 × 1 mm (in bud), glabrous; stamens about 200, to 3 mm (in bud), the anthers globose, 0.3 × 0.3 mm, eglandular; staminal ring to 2 mm in diameter; calyx tube 1–2 mm deep, glabrous; style to 4 mm (in bud), the stigma acute, minutely papillose; ovary with two locules and two ovules per locule. Fruits elliptic, immature, with trichomes as the flowers, 10 × 8 mm; seeds not examined.

Habitat, distribution and phenology.—*Calyptranthes solitaria* is a rainforest tree from the states of Minas Gerais, Rio de Janeiro and São Paulo, growing at altitudes between 850–1500 m; flowers were collected in February and April and fruits in May.

Conservation.—This species was collected in four municipalities of Minas Gerais, Rio de Janeiro and São Paulo, which total area is of 1,640 km² (IBGE 2014); these municipalities have been intensively surveyed, with 6,920 collections from Rio Preto, 2,262 from Salesópolis, 17,777 from Itatiaia and 18,585 from Ubatuba (data from CRIA 2014), with a collection density of 27.7 gatherings/km², which is notably higher than the Brazilian average (Sobral & Stehmann 2009); the relative scarcity of collections of this species may be an indicative of its

Fig. 1. *Calyptranthes solitaria*. Isotype at HUFSJ.

Fig. 2. *Calyptranthes solitaria*. Detail of inflorescences, from isotype (scale = 10 mm).

rareness. According to IUCN criteria (IUCN 2012), this species can be considered as vulnerable (VU), fitting criteria B1 ab(iii), since its extent of occurrence is less than 20,000 km² (criterion B1), its habitat is severely fragmented (criterion a) and the habitat quality and area are prone to decline, since two collection sites are not included in biological reserves and are under anthropogenic pressures such as farming and agriculture.

Affinities.—Due to its inflorescence structure, it is apparently related to *Calyptranthes tricona* D.Legrand (for description see Legrand & Klein 1971; Tressens & Rodríguez 1996; or Sobral 2003), a species from the Atlantic forest growing from Minas Gerais to Rio Grande do Sul, from which it can be distinguished by the combination of characters given in the diagnosis. The uniflorous inflorescences of this species are reminiscent of *Calyptranthes pauciflora* O.Berg (for description see Berg 1857–1859:543), from southeastern Brazil, which also show mostly inflorescences with solitary flowers but sometimes also triflorous. Nevertheless, in spite of the inflorescence character, this species does not seem related to *Calyptranthes solitaria*, due to its narrowly elliptic blades and the inflorescences and flowers with densely appressed trichomes.

Etymology.—The epithet is derived from the Latin word for "lonely" or "solitary," alluding to the uniflorous inflorescences.

Paratypes. **BRAZIL. Minas Gerais:** Mun. Rio Preto, Serra Negra, propriedade do sr. Nene Rock, 24 Apr. 2013, *K. Antunes & R.J.V. Alves 455* (CESJ, HUFSJ, R). **Rio de Janeiro:** Mun. Itatiaia, Parque Nacional de Itatiaia, trilha do hotel Simon para os Três Picos, 19 May 1999, *A. Quinet 226* (BHCB, RB). **São Paulo:** Mun. Ubatuba, 19 Apr 2007, *R. Bertoncello 122* (BHCB, UEC).

Calyptranthes ubatubana Sobral & Rochelle, sp. nov. (**Figs. 3–4**). Type: BRAZIL. São Paulo: mun. Ubatuba, Picinguaba, fazenda Capricórnio, Jul 2007, *A. Rochelle 228* (holotype: UEC, isotypes: HUFSJ, RB).

This species is related to *Calyptranthes lanceolata*, from which it is distinguished by the densely pilose inflorescences with flowers crowded at their apices (versus inflorescences and flowers glabrous, the inflorescences with flowers regularly distributed along axis).

Tree 3–7 m. Twigs terete, the young ones with a dense arachnoid indumentum of simple light brown to ochraceous trichomes, 2–2.5 mm long, soon deciduous, then the twigs completely glabrous, grey to dark brown, the distal internodes 35–50 × 2–3 mm, the one or two most distal internodes with stipule-like, lanceolate, adaxially folded cataphylls 40–50 × 8–10 mm, these occasionally with scattered asymmetrical dibrachiate trichomes 0.2–0.3 mm. Leaves with petioles 12–17 × 2 mm, glabrous or the young ones with trichomes as the twigs; blades oblong to oblong-lanceolate, 170–200 × 32–60 mm, 4 to 7 times longer than wide, glabrous or the young ones with scattered trichomes as the twigs along the midvein at the abaxial surface, concolorous when dry, with 4 to 5 glandular dots/mm², these smaller than 0.1 mm in diameter, visible abaxially; apex acuminate to 20 mm; base cuneate; midvein adaxially sulcate and prominent abaxially; lateral veins 25 to 35 at each side, visible and prominent on both sides, more so abaxially, departing from the midvein at 45–50°, with one to three secondary lateral veins between each pair; marginal veins two, 2–3 mm and 0.2–0.3 mm from the margin. Inflorescences paniculiform, axillary or terminal, ramified one to three times, pendulous, emerging with young shoots, the main axis 150–220 × 2–2.5 mm, slightly complanate, with a dense arachnoid indumentum

Fig. 3. *Calyptranthes ubatubana*. Unmounted isotype at HUFSJ.

Fig. 4. *Calyptranthes ubatubana*. Detail of inflorescence; from isotype (scale = 10 mm).

of simple light brown or ochraceous trichomes to 2.5 mm, these occasionally deciduous at anthesis, flowers 45 to 60, crowded apically in capituliform structures formed by three to five extremely reduced axes; basal bracts lanceolate, glabrous, adaxially folded, to 40 × 6 mm; bracts subtending the first ramifications lanceolate or ovate-lanceolate, glabrous, 10–12 × 3 mm; bracts subtending the reduced axes widely ovate, to 5–7 × 7 mm, slightly acuminate, with light brown, occasionally deciduous trichomes to 1 mm abaxially, the adaxial surface glabrous, the ultimate segments with three to five flowers, each subtended by one bract similar to the basal bract and with two elliptic to lanceolate bracteoles, 5–6 × 2–3 mm, glabrous adaxially and abaxially with brown simple trichomes to 1 mm, occasionally enveloping the flower buds, these elliptic to obovate, 5–6 × 2–3 mm, uniformly covered with brown trichomes 0.5–1 mm, with the calyx completely fused and a blunt apiculum to 1 mm; flowers opening through an irregular calyptra to 2 mm in diameter; petals not seen in the flowers examined, probably abortive; stamens 100 to 120, 6–7 mm, the anthers globose to oblate, 0.4–0.5 × 0.4–0.6 mm, eglandular, opening through longitudinal slits; staminal ring to 2 mm in diameter; calyx tube 2–2.5 mm deep; style 10–11 mm, the stigma slightly capitate and papillose; ovary with two locules and two ovules per locule. Fruits not seen.

Habitat, distribution and phenology.—*Calyptranthes ubatubana* is a tree from coastal rainforests of the northern portion of the Brazilian state of São Paulo, where it was collected at altitudes 350–400 m. Flowers were collected in April and July, but they were also observed in March (Rochelle, pers. obs.).

Conservation.—Considering the limited information currently available for this species, known for the moment from two collections, assigning a conservation status for it is premature, even considering the fact that it comes from the Brazilian Atlantic coastal forest, one of the most significant hotspots for conservation in the planet (Myers et al. 2000). Also, the existence of only two collections being known from a location intensively surveyed (20,324 gatherings in 723 km², with an average of 28 collections/km²; data from CRIA 2014 and IBGE 2014) may be an indicative of its rarity. Nevertheless, as there are no additional environmental informations, we think it is convenient for the moment scoring it as Data Deficient (DD), according to IUCN criteria (IUCN 2012).

Affinities.—This species is related to *Calyptranthes lanceolata* O. Berg (for description see Legrand & Klein 1971), a species also found in the Brazilian coastal Atlantic forest from the states of Rio de Janeiro to Santa Catarina, from which it can be distinguished through the characters cited in the diagnosis.

Etymology.—The epithet is derived from the municipality where the type specimen was collected.

Paratype. **BRAZIL. São Paulo:** Mun. São Sebastião, Parque Estadual da Serra do Mar, 23°45'S, 45°36'W, 20 Apr 2000, *A.A. de Oliveira et al.* (plus 9 collectors) *3624* (HUFSJ, UEC).

Eugenia dipetala Sobral & Kollmann, sp. nov. (**Figs. 5–6**). Type: BRAZIL. Espírito Santo: Mun. Santa Maria de Jetibá, 13 Mar 2003, *L. Kollmann 6035* (holotype: MBML; isotype: BHCB).

This species resembles in the leaf morphology *Eugenia gracillima*, but the blades are thicker, strongly bullate and markedly narrower in outline (versus more or less membranous, smooth and elliptic in outline). Additionally, the presence of only two petals distinguishes it from *E. gracillima* as well as from other species of *Eugenia* from southeastern Brazilian.

Shrub to 4 m. Twigs grey, subterete, with scattered white simple trichomes to 0.2 mm; internodes 20–25 mm. Leaves with petioles 1.5–2 × 0.4 mm; blades narrowly ovate, narrowly elliptic or oblong-ovate, 40–60 × 10–16

Fig. 5. *Eugenia dipetala*. Isotype at BHCB.

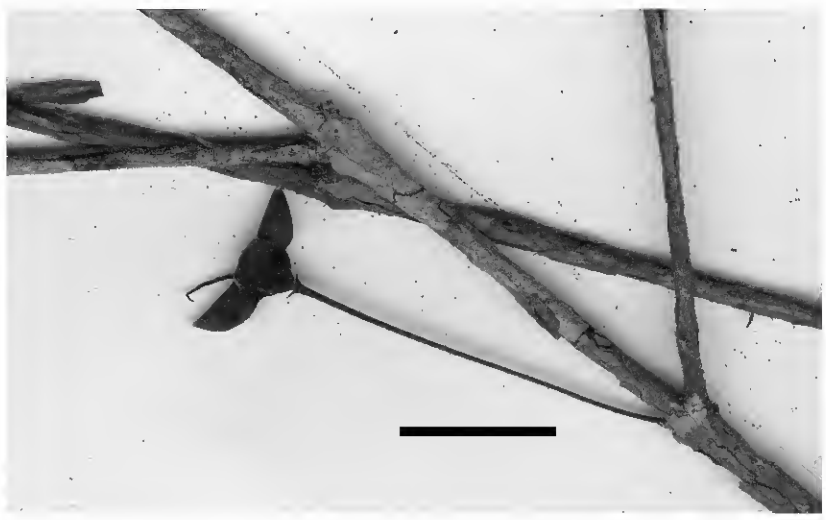


Fig. 6. *Eugenia dipetala*. Detail of old flower, from isotype (scale = 10 mm).

mm, slightly discolorous when dry, markedly bullate and glabrous adaxially, with scattered white trichomes to 0.2 mm abaxially; glandular dots visible against light, smaller than 0.05 mm in diameter and about 30/mm²; apex acuminate to 10–12 mm; base acute or obtuse; midvein sulcate adaxially and prominent abaxially; lateral veins 15 to 20 pairs, leaving the midvein at angles of 80–90 degrees, sulcate adaxially and prominent abaxially; intramarginal vein 0.3–0.5 mm from the revolute margin. Flowers 1 or 2 per axile; pedicels 16–20 × 0.4–0.5 mm, pilose as the blades; bracteoles triangular-lanceolate, 0.8–1 × 0.6–0.8, with cilia to 0.1 mm, persisting after anthesis; flower buds globose to obovate, to 4 × 3 mm, with white trichomes to 0.1 mm, these occasionally more dense on the ovary; calyx lobes four, elliptic to rounded, concave, somewhat unequal, 2–3.5 × 1.8–4 mm; petals two in the flowers examined, rounded, glabrous, white, markedly concave, to 3–5 × 3–5 mm; stamens 70 to 80, 3.5–4.5 mm; anthers elliptic, 1 × 0.5–0.6 mm, eglandular; staminal ring 2–3 mm in diameter; style 4–5 mm, stigma punctiform or slightly capitate, minutely papillose; ovary locules 2; ovules 4 to 5 per locule. Fruits unknown.

Habitat, distribution and phenology.—This species is a shrub from forests of the montane region of central Espírito Santo. It is presently known only from the type collection, from the municipality of Santa Maria de Jetibá. Flowers were collected in March.

Conservation.—The municipality of Santa Maria de Jetibá encompasses an area of 735 km² (IBGE 2014), from from which 2,233 collections have been made (CRIA 2014), with a moderate average of 3 collections/km²; considering this, the uniqueness of the type specimen may be an indicative of its rareness. Nevertheless, considering the absence of additional information, it seems more adequate to score this species as Data Deficient (DD), according to IUCN criteria (IUCN 2012).

Etymology.—The epithet alludes to the two petals in all presently examined flowers of the species, a curious feature evident among all flowers examined in our study, but otherwise unknown for species of the genus, at least in southeastern Brazil.

Affinities.—The leaves of this species somewhat resemble those of *Eugenia gracillima* Kiaerskou (for description see Kiaerskou 1893:120), differing through the characters cited in the diagnosis.

Myrcia cacuminis Kollmann & Sobral, sp. nov. (**Figs. 7–8**). Type: BRAZIL. Espírito Santo: Mun. Águia Branca, 18°56'39"S, 40°47'55"W, 6 Sep 2006, *L. Magnago, V. Demuner, T. Cruz & E. Bausen 1341* (holotype: MBML; isotype: BHCB).

This species is apparently related to *Myrcia capitata,* from which it is distinguished by the petiolate, narrowly elliptic leaves with mostly glabrous adult blades (vs. sessile, ovate, abaxially pilose blades) with cordate bases (vs. cuneate bases) and up to three flowers per inflorescence (vs. five to seven flowers).

Shrub 2–3 m. Twigs terete, 0.8–1.2 mm in diameter at the most distal internode, glabrous or with simple white trichomes to 0.3 mm. Leaves with petioles 4–5 × 0.3–0.7 mm, glabrous or with trichomes to 0.2 mm; blades ovate to narrowly elliptic, 40–54 × 13–22 mm, 2.4–3 times longer than wide, glabrous or with scattered trichomes 0.3–0.4 mm along the midvein adaxially, the indumentum sometimes dense in young blades, concolorous when dry; glandular dots about 0.05 mm in diameter, 10 to 20/mm², visible on both sides; apex and base acute; midvein adaxially sulcate and abaxially prominent; lateral veins 12 to 17 at each side, visible and moderately prominent on both sides, leaving the midvein at angles 60–70 degrees; marginal veins two, 1–1.3 mm and 0.2–0.3 mm from the margin, the margin itself with grey cilia to 0.3 mm at least on young leaves. Inflorescences emerging below the leaves, but coeval with them, one pair in each branch, the axis 20–35 × 0.5–0.6 mm, with simple white trichomes 0.5–0.6 mm, with 2 or 3 sessile and apically crowded flowers; bracts three to five,

Fig. 7. *Myrcia cacuminis*. Isotype at BHCB.

Fig. 8. *Myrcia cacuminis*. Detail of inflorescence, from isotype (scale = 10 mm).

foliaceous, directly subtending the flowers, narrowly ovate to ovate, 9–10 × 4–4.5 mm, with cilia to 0.3 mm; bracteoles foliaceous, ovate to narrowly ovate, to 5 × 2 mm, ciliate as bracts; flower buds globose or obovate, 4 × 3–4 mm, with white trichomes to 0.3 mm, the hypanthium densely pilose; calyx lobes five, subequal, triangular, 2.5–3 × 2 mm; petals rounded or oblate, 3–3.2 × 3.5 mm, white, ciliate; stamens about 100 (based on scars over staminal ring); staminal ring 2–3 mm in diameter; calyx tube 0.5–1 mm deep; style to 9 mm, stigma punctiform and minutely papillose; ovary bilocular, ovules 2 per locule. Fruits globose or oblate, 5–6 × 6–7 mm, unripe in the specimens examined, seeds 2 to 3, reniform, 4–5 × 4 mm, testa light brown, glossy and easily detachable; embryos not completely developed.

Habitat, distribution and phenology.—*Myrcia cacuminis* is a shrub from rocky outcrops at altitudes from 100 to 900 m; it is presently known for the municipalities of Águia Branca and São Roque do Canaã, in the center of the southeastern Brazilian state of Espírito Santo. Flowers and fruits were collected in October.

Conservation.—This species comes from two municipalities from central Espírito Santo, Águia Branca, and São Roque do Canaã, with respectively 454 and 342 km² (IBGE 2014) and 2,447 and 1,601 collections from each (CRIA 2014), resulting in an average of about five collections/km², a reasonable amount of gatherings. Considering this, the small amount of collections may be an indicative of its rareness. Additionally, it fulfills criteria B1 ab(iii) for Endangered (IUCN 2012), since the presently known range of the species is less than 5,000 km² (criterium B1), its habitat also is severely fragmented (Aguiar et al. 2005) (criterium a) and presents a continuing decline in extension (criterium b(iii)), since municipalities in central Espírito Santo have been intensely deforested. (See Mendes & Padovan (2000) for data regarding the neighbouring municipality of Santa Teresa.)

Affinities.—Due to its inflorescence structure, it is apparently related to *Myrcia capitata* O. Berg (for description see Berg 1857–1859:154), a species collected in the cerrados of the state of Minas Gerais, from which it is kept apart by the characters given in the diagnosis.

Etymology.—The epithet is derived from the Latin word for "summit," and alludes to the rocky outcrops on mountain tops where the species was collected.

Paratypes. **BRAZIL. Espírito Santo:** Mun. Águia Branca, 18°56'39"S, 40°47'55"W, 6 Sep 2006, *L. Magnago et al. 1358* (BHCB, MBML, RB); 18°58'40"S, 40°39'56"W, 18 Oct 2006, *V. Demuner et al. 2948* (MBML); mun. São Roque do Canaã, São Jacinto, Militon, 16 Oct 2004, *L. Kollmann et al. 7069* (BHCB, MBML); idem, Misterioso, Pedra dos Três Carneiros, 24 Oct 2004, *Kollmann et al. 7126* (BHCB, MBML).

Plinia ambivalens M. Souza & Sobral, sp. nov. (**Figs. 9–10**). Type: BRAZIL. Bahia: Mun. Arataca, RPPN Caminho das Pedras, em trilha de acesso ao Peito de Moça; 15°10'25"S, 39°20'30"W, 6 Aug 2006, *M.M.M. Lopes, P. Labiak, J. Paixão & L. Gomes 1015* (holotype CEPEC; isotypes BHCB, NY).

This species is apparently related to *Plinia involucrata,* from which it is distinguished by the leaves with petioles to 4 mm (versus up to 3 mm in *P. involucrata*) and blades with midvein and lateral veins visible and moderately raised on both faces (vs. scarcely visible on both faces) and locules with three or more ovules (vs. biovulate locules).

Tree to 13 m. Twigs with white appressed trichomes to 0.5 mm; internodes 15–25 × 1–2 mm, subterete, sometimes longitudinally striate. Leaves with petioles 7–13 × 0.9–1.2 mm; blades elliptic, narrowly elliptic or elliptic-obovate, 65–90 × 30–40 mm, 2–2.3 times longer than wide, slightly discoloured, with white appressed trichomes to 0.5 mm scattered adaxially, more dense but not concealing the surface abaxially, glandular dots smaller than 0.1 mm in diameter, sometimes visible on the surfaces, more visible against light, to 10/mm²; apex acuminate to 5–7 mm; base cuneate or attenuate; midvein plane, biconvex or salient adaxially, prominent abaxially; lateral veins 15–20 pairs, visible and moderately salient on both faces; marginal vein 1–2 mm from the revolute margin. Inflorescences axillary, glomeruliform, the axis 1–2 × 1.5 mm, with 2 to 4 sessile flowers; bracts ovate to widely ovate, basally with 4 to 10 linear colleters 0.3–0.4 × 0.05 mm adaxially, glabrous or with cilia to 0.1 mm, in 3–4 series, progressively larger distally, the basal ones to 1 × 1.5 mm, the most distal ones to 2 × 2.5 mm, these occasionally tearing in two halves due to the development of the flowers; bracteoles apparently in two pairs (the proximal pair more properly a bract, that is, the axis from where the flower arises must be considered a brachyblast), the proximal pair elliptic-ovate, 2–2.2 × 1.5 mm, with scattered simple trichomes to 0.1 mm, initially fused at least partly, the distal pair elliptic-rounded, to 3 × 2 mm, glabrous or

Fig. 9. *Plinia ambivalens*. Isotype at BHCB.

with scattered trichomes to 0.1 mm, with evident cilia to 0.1 mm, partially fused at base, persisting after anthesis; flowers buds obovate, 4–5 × 4 mm, uniformly covered with white or grey simple trichomes 0.5–0.6 mm, with calyx lobes fused; calyx lobes three to four, tearing irregularly, to 1–2 × 2 mm, generally one lobe evidently larger than the others, calyptriform; petals, in the flowers examined, two to three, obovate, to 3 × 2 mm, somewhat vestigial; stamens about 100, 5–6 mm, anthers elliptic, 0.3–0.4 × 0.2, sometimes with one connectival gland; staminal ring 2–3 mm in diameter; calyx tube 1 mm deep, glabrous, persisting after anthesis; style to 6 mm, glabrous, stigma punctiform, papillose; ovary with two internally glabrous locules and three to six ovules per locule. Fruits unknown.

Distribution, habitat and phenology.—This species is known from montane rainforests of central Espírito Santo and southern Bahia, where it grows at altitudes 800–1000 m above sea level. Flowers were collected in July and August.

Conservation.—*Plinia ambivalens* was collected in localities more than 500 km apart, which makes its possible occurrence area larger than 20,000 km², suggesting it could be scored, according to IUCN criteria (IUCN 2012) as a species of least concern (LC).

Fig. 10. *Plinia ambivalens*. Detail of flower bud, from isotype (scale = 10 mm).

Affinities.—This species shows a troubling combination of characters that puts it on the border of two closely related genera, *Plinia* and *Neomitranthes* Kausel ex D. Legrand (for description see Legrand & Klein 1977). Both genera are nested in the *Plinia* group as defined by Lucas et al. (2007), characterized by embryos with plano-convex cotyledons and a mean of nine ovules per locule, among other features. In practical grounds, *Neomitranthes* and *Plinia* can be distinguished by the completely closed calyx that opens through a calyptra and a high number of ovules per locule in *Neomitranthes*, while *Plinia* presents a calyx incompletely closed, rarely forming a calyptra, and mostly two ovules per locule. The combination of characters present in *P. ambivalens* leads to a dilemma, since it has a high number of ovules per locule (typical of *Neomitranthes*) combined with an incompletely closed calyx that tears in irregular lobes, occasionally one of them calyptriform (typical of *Plinia*). Our decision for assigning the present species to *Plinia* rather than to *Neomitranthes* resides in the arrangement of involucral bracts in the inflorescence, a feature apparently absent in *Neomitranthes*.Another quite plausible possibility is that we are dealing with only one variable genus instead of two distinct lineages; if this comes to be proved as the case, then *Plinia* would have priority over *Neomitranthes*, and our choice would at least avoid one more combination in the overburdened nomenclature of the family. Additionally, we are not aware of any species of *Neomitranthes* that should be compared with *Plinia ambivalens*, while among the presently known species of *Plinia* it shows great similarity with the Amazonian *Plinia involucrata* (O. Berg) McVaugh (for description see Berg, 1857–1859:375, under *Myrciaria involucrata*; McVaugh 1958:779 under *Plinia pinnata* and McVaugh 1969:228), from which it is distinguished by the characters listed in the diagnosis.

Etymology.—The epithet alludes to the mixture in this species of characters of the genera *Neomitranthes* and *Plinia* as they are presently defined.

Paratypes.—**BRAZIL. Espírito Santo:** Mun. Santa Teresa, São Antônio, 20 Jul 1999, *L. Kollmann, W. Pizziolo & E. Bausen 2704* (BHCB, MBML, RB); idem, Parque Natural de São Lourenço, árvore 13 m, DAP 57 cm, flor branca, meia encosta, 9 Sep 2003, *T.A. da Cruz, I.N. Subtil & D.T. da Cruz 1* (BHCB, MBML, RB).

Observations.—The collection *Cruz et al. 1* is registered under this number in MBML and in speciesLink (CRIA 2014); some duplicates, however, have been distributed as *Cruz et al. 669* (the data in the labels are identical, and at least the duplicate at BHCB has the number 669 erased and replaced by number 1).

ACKNOWLEDGMENTS

We are grateful for the collectors of the cited specimens and for the curators of cited herbaria for their valuable help, for Rafaela Forzza, Érika von Sohsten Medeiros and Mariana Bünger for their help in preparing the illustrations and to Barney Lipscomb and two anonymous reviewers for very useful suggestions that improved our paper.

REFERENCES

Aguiar, A.P., A.G. Chiarello, S.L. Mendes, & E.N. de Matos. 2005. Os corredores central e da Serra do Mar na mata atlântica brasileira. In: C. Galindo-Leal & I.G. Câmara, eds. Mata atlântica, biodiversidade, ameaças e perspectivas. Belo Horizonte, Fundação SOS Mata Altântica/Conservação Internacional. Pp. 119–132.

Berg, O. 1857–1859. Myrtaceae. In: K.F.P. von Martius, org. Flora Brasiliensis 14(1):1–656.

CRIA (Centro de Referência em Informação Ambiental). 2014. Specieslink (http://www.splink.org.br/index?lang=pt).

Galindo-Leal, C. & I.G. Câmara. 2005. Status do hotspot mata atlântica: uma síntese. In: C. Galindo-Leal & I.G. Câmara, eds. Mata atlântica. Biodiversidade, ameaças e perspectivas. Belo Horizonte, SOS Mata Atlântica, Conservação Internacional. Pp. 3–11.

IBGE (Instituto Brasileiro de Geografia e Estatística). 2014. IBGEcidades@ (http://www.ibge.gov.br/cidadesat/default.php).

IUCN (International Union for the Conservation of Nature). 2012. IUCN red list categories and criteria: Version 3.1. 2nd ed. IUCN, Species Survival Commission, Gland, Switzerland. (on-line version at http://www.iucnredlist.org/technical-documents/categories-and-criteria)

Kiaerskou, H. 1893. *Enumeratio myrtacearum brasiliensium quas collegiunt Glaziou, Lund, Mendonça, Raben, Reinhardt, Schenck, Warming alique.* In: E. Warming, ed. Symbolarum ad floram Brasiliae Centralis cognoscendam 39:1–199.

Landrum, L.R. & M.L. Kawasaki. 1997. The genera of Myrtaceae in Brazil: An illustrated synoptic treatment and identification keys. Brittonia 49:508–536.

Legrand, C.D. & R.M. Klein. 1971. Mirtáceas - *Calyptranthes*. In: R. Reitz, org. Flora ilustrada Catarinense, Itajaí. Pp. 489–552.

Legrand, C.D. & R.M. Klein. 1977. Mirtáceas - *Campomanesia, Feijoa, Britoa, Myrrhinium, Hexachlamys, Siphoneugena, Myrcianthes, Neomitranthes, Psidium*. In: R. Reitz, org. Flora ilustrada Catarinense, Itajaí. Pp. 571–730.

Lucas, E.J., S.A. Harris, F.F. Mazine, S.R. Belsham, E.M. NicLughadha, A. Telford, P.E. Gasson, & M.W. Chase. 2007. Suprageneric phylogenetics of Myrteae, the generically richest tribe in Myrtaceae (Myrtales). Taxon 56:1105–1128.

McVaugh, R. 1958. Flora of Peru - Myrtaceae. Publ. Field Mus. Nat. Hist., Bot. Ser. 13(4):569–819.

McVaugh, R. 1969. Flora of the Guayana Highland - Myrtaceae. Mem. New York Bot. Gard. 18:55–286.

Mendes, S.L. & M.P. Padovan. 2000. A Estação Biológica de Santa Lúcia, Santa Teresa, Espírito Santo. Boletim do Museu de Biologia Mello Leitão (nova série) 11/12:7–34.

Myers, N., R. Mittelmeier, C. Mittelmeier, G.A.B. Fonseca, & J. Kent. 2000. Biodiversity hotspots for conservation priorities. Nature 403:853–858.

Silva, J.M.C. & C.H.M. Casteleti. 2005. Estado da biodiversidade da mata atlântica brasileira. In: C. Galindo-Leal & I.G. Câmara, eds. Mata atlântica. Biodiversidade, ameaças e perspectivas. Belo Horizonte, SOS Mata Atlântica, Conservação Internacional. Pp. 43–59.

BROWNEOPSIS PUYENSIS (LEGUMINOSAE: CAESALPINIOIDEAE: DETARIEAE), A NEW SPECIES FROM AMAZONIAN ECUADOR

David A. Neill and Mercedes Asanza

Universidad Estatal Amazónica
Puyo, Pastaza, ECUADOR
davidneill53@gmail.com
gman2260@gmail.com

ABSTRACT

Browneopsis puyensis D.A. Neill & Asanza (Leguminosae: Caesalpinioideae: Detarieae), a new species known only from a single adult tree in a riverside urban park in the city of Puyo, the capital of Pastaza province at the western edge of the Amazon basin in Ecuador, is described and illustrated. The new species is a large canopy tree attaining 30 m, and the ramiflorous inflorescences are borne on large horizontal limbs. The white, nocturnal flowers are protogynous, a feature not reported previously for *Browneopsis* or related genera in the tribe Detarieae.

RESUMEN

Se describe y se ilustra **Browneopsis puyensis** D.A. Neill & Asanza (Leguminosae: Caesalpinioideae: Detarieae), una especie nueva conocida únicamente de un solo árbol adulto en un parque urbano ribereño en la ciudad de Puyo, la capital de la provincia de Pastaza en la margen occidental de la llanura amazónica de Ecuador. La especie nueva es un árbol grande de 30 m de altura, y las inflorescencias ramifloras salen de las ramas principales horizontales. Las flores blancas y nocturnas son protóginas, una característica no reportada previamente para *Browneopsis* o para géneros afines de la tribu Detarieae.

The genus *Browneopsis* Huber comprises seven known species from the western Amazon basin in Ecuador, Peru and western Brazil, the Chocó biogeographic region along the Pacfiic coast of Colombia and Ecuador, including the Magdalena valley of Colombia, and the Darién region of eastern Panama (Klitgaard 1991; Lewis et al. 2005; Silverstone-Sopkin 2010). *Browneopsis* is separated from the related genus *Brownea* Jacq. by several floral characteristics: *Browneopsis* lacks bracteoles and some or all of the petals are reduced in size, or entirely lacking, and the floral parts of *Browneopsis* are white or cream whereas those of *Brownea* are red, orange, pink (yellow in one recently described species, *Brownea jaramilloi* A.J. Pérez & Klitg.; Pérez et al. 2012). The floral features are correlated with differences in pollinators: the red, diurnal flowers of *Brownea* pollinated by hummingbirds and the white, nocturnal flowers of *Browneopsis* pollinated by bats or moths. A molecular phylogeny using chloroplast trnL intron sequences (Bruneau et al. 2001) suggested that *Browneopsis* and *Brownea* are not monophyletic, but that more comprehensive sampling is needed (Lewis et al. 2005).

Browneopsis ucayalina Huber is locally common in Amazonian Ecuador and Peru, with up to 47 individuals recorded in one-hectare forest inventory plots (data from unpublished appendix to ter Steege et al. 2013), but most of the other species are evidently quite rare, and several are listed as Critically Endangered (CR) or Endangered (EN) according to the IUCN Red List categories (IUCN 2001): *B sanintiae* Silverst. in Colombia and *B. macrofoliolata* Klitg. and *B. disepala* (Little) Klitg. in coastal Ecuador (Silverstone-Sopkin 2010; Neill 2011). We describe herein an additional species of *Browneopsis* from Amazonian Ecuador that, based on available evidence, is also rare and endangered.

Browneopsis puyensis D.A. Neill & Asanza, sp. nov. (**Figs.1, 2**). TYPE. ECUADOR: PASTAZA PROVINCE: Pastaza cantón, Puyo, River walk along the Río Puyo, the "Paseo Turístico" between the campus of the Universidad Estatal Amazónica and the "malecón" near the city center, 1°28'10"S 77°59'40"W, 950 m, 26 Mar 2013 (fl.), *David Neill, Javier Robayo & Mercedes Asanza 17614* (HOLOTYPE: ECUAMZ: ISOTYPES: K, MO, NY, QCNE).

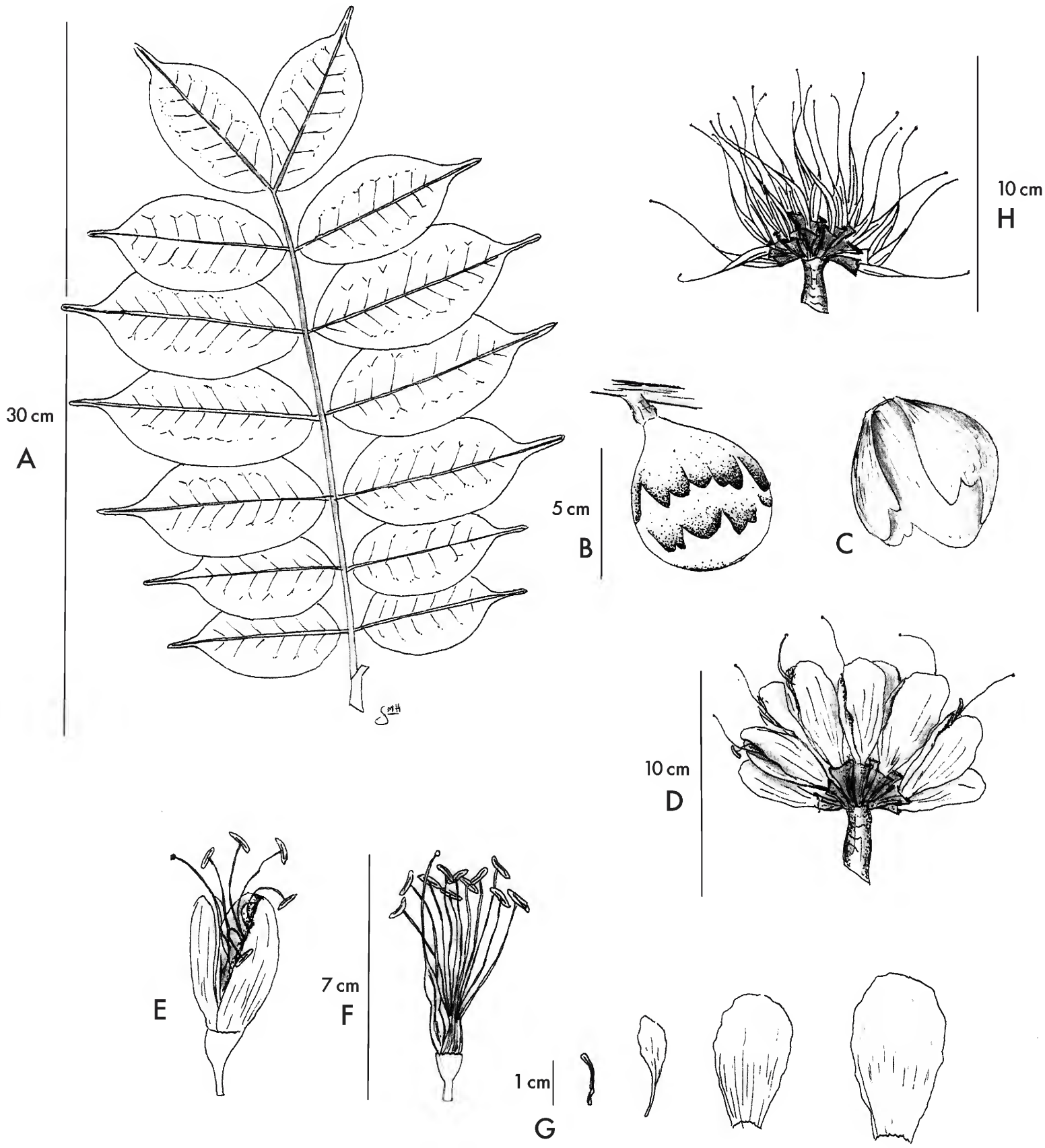


Fig. 1. *Browneopsis puyensis* D.A. Neill & Asanza. A. Leaf. B. Inflorescence bud. C. Inflorescence bract. D. Protogynous inflorescence in the female phase. E. Open flower with sepals. F. Flower after the sepals are shed. G. Sepals, showing range of sizes. H. Inflorescence with pistils after sepals and stamens have been shed; no fruit set was observed after this stage of flowering. Drawn from the type collection, *Neill et al. 17614*.

This species differs from other taxa of *Browneopsis* in the combination of characters including its large stature, a 30-m canopy-level tree; the number of leaflets, with 7(–8) pairs of leaflets with long-acuminate apices; inflorescence position, with inflorescences ramiflorous, borne on large horizontal limbs, not cauliflorous, axillary or terminal; and presence of only one vestigial, minute petal, or petals entirely absent.

Tree attaining 30 m, with trunk 66 cm diameter. Bark densely lenticellate, gray. Wood very hard and heavy. Crown cylindrical with large horizontal limbs. Young branchlets, petioles and adaxial leaf surfaces densely pubescent with light brown simple hairs, all parts becoming glabrescent with age. Leaves alternate, paripinnate, with 7(–8) pairs of leaflets; leaflets opposite to subopposite. Petiole + rachis 20–27 cm. Blades coriaceous,

Fig. 2. Photograph of protogynous inflorescence of *Browneopsis puyensis*, in the female phase, shortly after anthesis in late afternoon before the first night of flowering; the styles are exserted and beginning to straighten out, but the staminal filaments remain curled and covered by the cucullate sepals until the following evening.

glaucous with a waxy coat on adaxial surface, becoming glabrescent with age. Proximal pair of leaflets shorter than the 6(–7) distal pairs, broadly ovate, 4.5–6 cm × 1.8–3.2 cm, base rounded and mostly asymmetrical, apex long-acuminate. Distal leaflets elliptic to narrowly lanceolate, 7–12 × 3–4 cm, base rounded and asymmetrical or nearly symmetrical, apex long-acuminate. Inflorescences ramiflorous, borne on short shoots emerging from large horizontal limbs, or on medium-diameter branches but not on small distal leafy branches, usually erect but sometimes descending. Inflorescence bud globose, 6–8 cm in diameter, enclosed by 4–6 inflorescence bracts. Bracts cucullate, 5–6 cm × 4–5 cm, apex rounded, base truncate, white, with dense light brown pubescence on abaxial surface; the adaxial surface glabrous or with a few scattered simple brown hairs. Flowers ca. 30–40 per capitulum, sessile, bracteoles absent; hypanthium 12–15 mm × 5–6 mm, glabrous; sepals 3–4, with 2 larger sepals and 1–2 smaller ones, larger sepals 35–40 × 15–18 mm, spathulate, cucullate, rounded at apex, white with light brown pubescence on lower third of abaxial surface, smaller sepals 20–25 × 3–4 mm, narrowly spathulate, apex acute, petals 0–1, vestigial, ca. 2–3 × 1–2 mm, subulate; stamens 14–16, basally connate,

tube + free filaments 55–65 mm, filaments fused in basal 15–20 mm, tube open on one side, white, glabrous, anthers versatile, ca. 6 × 1.5 mm; ovary + style 65–70 mm, ovary 15–20 × 3–4 mm, densely villous with light brown hairs; style and stigma glabrous, stigma subcapitate. Fruit not seen.

Browneopsis puyensis is a large, canopy-level tree attaining 30 m in height, whereas most other species of *Browneopsis* are smaller understory or subcanopy trees in humid lowland forests (Klitgaard 1991). An exception may be *Browneopsis excelsa* Pittier in the Darién region of Panama, which has been described as a large 30-m tree (Schery 1951). With its 7(–8) pairs of leaflets, *B. puyensis* differs from its congeners in numbers of leaflets: 2–3 pairs in *B. excelsa, B. macrofoliolata* and *B. peruviana* (J.F. Macbr.) Klitg., 2–4 pairs in *B. cauliflora* (Poepp. & Endl.) Huber, 4–6 pairs in *B. sanintiae*, and 8–11 pairs in *B. disepala*. The leaves of *B. puyensis* are remarkably similar to those of *Brownea grandiceps* Jacq. in the size, shape and number of leaflets. The latter species occurs in Amazonian Ecuador, but at lower elevations and farther east than *B. puyensis*, and is a small understory tree with terminal inflorescences and red flowers; in sterile condition, juvenile plants of these two species in different genera may be quite indistinguishable. The position of the inflorescence in *B. puyensis*, ramiflorous and usually erect on large principal branches, is unique among its congeners: *B. ucayalensis* and *B. cauliflora* have cauliflorous inflorescences along the trunk, and the remaining species have terminal, subterminal or axillary inforescence on small branches.

Distribution and ecology.—*Browneopsis puyensis* is known only from a single large adult individual, growing in the middle of a brick sidewalk constructed around the base of the tree in recent years, along the "Paseo Turístico" on the banks of the Puyo River in the city of Puyo, the capital of Pastaza province, Ecuador, at 950 m elevation. The site is about 100 m from the entrance to the campus of the Universidad Estatal Amazónica, within a small and narrow remnant of primary forest trees along the river. Beside the adult tree is a 4 m juvenile treelet of the same species, and several small saplings less than 1 m tall are in the forest understory near the adult. The original forest in the area around Puyo has almost entirely been deforested and the land converted to pastures, sugar cane fields and urban-suburban development, and a search for additional adult trees of this species was not successful. Mr. Rafael Sancho, the former mayor of Puyo, described to the authors his initiative to protect the riverine forest during his mayoral tenure, 1978–1982; at that time, a larger area of relatively intact forest was still extant along the Puyo River, but subsequent municipal administrations did not continue the conservation efforts and most of the remaining primary forest was lost during the following decades. The present brick walkway, the "Paseo Turístico Río Puyo", was built by the Ministry of Tourism in 2010 and the walkway is a favorite site for residents and visitors to stroll, jog and sometimes to swim in the river; besides *Browneopsis puyensis*, several other rare and locally endemic tree species occur in the narrow belt along the riverine park within the urban core of Puyo. The site is 20 km east of the eastern base of the Andes with a wet aseasonal climate; annual precipitation in Puyo is about 4000 mm; in the recently completed vegetation map of Ecuador (Ministerio del Ambiente 2012), the original vegetation of the area is designated "Bosque siempreverde piemontano del Norte de la Cordillera de los Andes". Growth rates of this species are not known, but judging from the very dense heavy wood, evident in the branch wood, and the slow growth rates observed by the authors in other genera and species of Detarieae in Amazonia, the 30-m, 66-cm diameter individual of *B. puyensis* is probably several centuries old and predates the late 19th-century founding of the city of Puyo by a wide margin.

Etymology.—The specific epithet refers to the city of Puyo, the capital of Pastaza province, where the only known adult and juvenile individuals are known. The city`s name is derived from the word "puyu" in Kichwa, the language of the indigenous people of the region, and signifies "mist," a term which aptly describes the perhumid climate of the site.

Phenology and protogyny.—The large adult individual of *Browneopsis puyensis* flowered abundantly for about a month each year it was observed, during late March to late April in 2013 and again in 2014. No fruits were set in either year; however, the caretakers of the urban park along the Puyo River informed the authors that in some past years, fruits matured with viable seeds during August. The presence of a few juvenile individuals near the base of the large flowering tree suggests that seed production has indeed occurred. No addi-

tional adult trees are known, and if the species is mostly self-incompatible but with occasional fruit set from geitonogamous pollination, a low incidence of mature seed production could be expected.

The flowers of *Browneopsis puyensis* are protogynous at the level of the inflorescence. We observed that the inflorescence buds open in late afternoon, and during the first night of anthesis, the styles are fully exserted and straight, but the stamens remain curled up within the "pockets" of the two large cucullate sepals (Fig. 2.). On subsequent nights, the sepals fall away and the staminal filaments are fully extended. The female phase of the protogynous inflorescences may sometimes last more than one night before the sepals dehisce and the staminal filaments unfurl completely. Protogyny in inflorescences of *Browneopsis disepala* from coastal Ecuador was previously described by Knudsen and Klitgaard (1998) as part of an extensive study of the pollination biology and floral scent of that species. At night, we observed the inflorescences with the aid of binoculars, looking for floral visitors, and detected hawkmoths in the vicinity of the inflorescences but were not able to confirm that they actually visited the flowers.

IUCN Red List Category.—Browneopsis puyensis is known at present from a single adult individual with flowers that may be mostly, though perhaps not completely, self-incompatible. Like most taxa in the tribe Detarieae, the species is probably slow-growing and confined to primary forest under natural conditions. The region around the city of Puyo where this single tree was found has been largely deforested in recent decades and no other fragments of primary forest have been found with this species present. In lieu of a comprehensive search and a population study, it is logical to place the new species in the highest threat category of the IUCN Red List system (IUCN 2001): Critically Endangered (CR). Given the easy accessibility of the one known flowering individual, it will be monitored in future years for possible fruit set, and vegetative propagation *ex situ* of this species will be carried out by the Universidad Estatal Amazónica, following the guidelines of the Global Strategy for Plant Conservation (http://www.cbd.int/gspc/strategy.shtml) adopted by the nations that are parties to the Convention on Biological Diversity.

ACKNOWLEDGMENTS

We thank Julio Cesar Vargas, Rector of the Universidad Estatal Amazónica (UEA), for his support for our research and for the development of the UEA's new herbarium, the Herbario Amazónico del Ecuador (ECUAMZ); Rafael Sancho, former mayor of Puyo, prefect of Pastaza and legislative representative for the province, for his efforts to promote the conservation of the Puyo River forest remnants, and his descriptions of the development of the city over the past 50 years; Javier Robayo, for his help in obtaining the type specimens; and Eric Meza Andrade for the line drawing of the new species. We thank Bente Klitgaard (k) and one anonymous reviewer for helpful comments.

REFERENCES

Bruneau, A., F. Forest, P.S. Herendeen, B.B. Klitgaard, & G.P. Lewis. 2001. Phylogenetic relationships in the Caesalpinioideae (Leguminosae) as inferred from chloroplast trnL intron sequences. Syst. Bot. 26(3):487–514.

IUCN (International Union for Conservation of Nature and Natural Resources). 2001. IUCN Red List Categories and Criteria, Version 3.1. IUCN, Gland, Switzerland, and Cambridge, U.K. http://www.iucn.org.

Klitgaard, B.B. 1991. Ecuadorian *Brownea* and *Browneopsis* (Leguminosae-Caesalpinioideae): Taxonomy, palynology, and morphology. Nordic J. Bot. 11:433–449.

Knudsen, J.T. & B.B. Klitgaard. 1998. Floral scent and pollination in *Browneopsis disepala* (Leguminosae: Caesalpinioideae) in western Ecuador. Brittonia 50(2):174–182.

Lewis, G.P., B. Schrire, B. Mackinder, & M. Lock. 2005. Legumes of the World. Royal Botanical Gardens, Kew, Richmond, Surrey, U.K.

Ministerio del Ambiente (Ecuador). 2012. Mapa de ecosistemas del Ecuador Contiental. Ministerio del Ambiente, Quito, Ecuador.

Neill, D.A. 2011. Fabaceae. In: S. León-Yánez, R. Valencia, L. Endara, C. Ulloa Ulloa, & H. Navarrete, eds. Libro rojo de las plantas endémicas del Ecuador, 2ª edición. Pontificia Universidad Católica del Ecuador, Quito, Ecuador. Pp. 325–335.

Pérez, A.J., B.B. Klitgaard, C. Saslis-Lagoudakis, & R. Valencia. 2012. *Brownea jaramilloi* (Leguminosae: Caesalpinioideae), a new, over-looked species endemic to the Ecuadorian Amazon. Kew Bull. 68:157–162.

Schery, R.W. 1951. Flora of Panama: Leguminosae-Caesalpinioideae. Ann. Missouri Bot. Gard. 38(1):1–94.

Silverstone-Sopkin, P.A. 2010. A new species of *Browneopsis* (Leguminosae, Caesalpinioideae) from the Cauca valley, Colombia. Novon 20:207–211.

ter Steege, H. (and 119 others). 2013. Hyperdominance in the Amazonian tree flora. Science 342(6156):1243092. DOI:10.1126/science.1243092

A NEW SPECIES OF *GARNOTIA* (POACEAE) FROM KERALA, INDIA

C.N. Sunil, V.V. Naveen Kumar, and M.G. Sanilkumar

Post Graduate and Research Department of Botany
SNM College, Maliankara
Ernakulam District, Kerala, INDIA
dr.cnsunil@yahoo.in

ABSTRACT

Garnotia variyamensis Sunil, Naveen Kumar, & Sanilkumar, a new species of *Garnotia* from Ernakulam District of Kerala, India, is described and illustrated. The species is distinguishable by the presence of dissimilar spikelet pairs, with one sessile or nearly so with an unawned lemma with empty or male flowers, the other pedicelled with a shortly bifid lemma with a geniculate awn in the sinus and bisexual flowers. The species is also notable by the awned glumes and broad axes of the panicle and its branches. The novelty is probably allied to *Garnotia courtallensis*.

KEY WORDS: Poaceae, Garnotieae, *Garnotia variyamensis,* new species, India, Kerala, Ernakulam District

RESUMEN

Garnotia variyamensis Sunil, Naveen Kumar, & Sanilkumar, es una nueva especie de *Garnotia* de Ernakulam Distrito de Kerala, India, que se describe y se ilustra. La especie se distingue por la presencia de pares de espiguillas disimilares, una sésil o casi con un lema mútico con flores vacías o masculinas, la otra pedicelada con un lema cortamente bífido con una arista geniculada en el seno y flores bisexuales. La especie es también notable por sus glumas múticas y ejes de la panícula y sus ramas anchos. La novedad está relacionada con *Garnotia courtallensis*.

INTRODUCTION

The genus *Garnotia* Brongn. (Subfamily-Panicoideae, Tribe-Garnotteae)is represented by ca. 39 species distributed in Asiatic and Pacific regions of the world (Mabberley 2008). Gould (1972) while revising *Garnotia*, recognized 29 species and six varieties and categorised them under two sections, sect. *Garnotia* and sect. *Scoparia*. In India, *Garnotia* is represented by about 12 species (Prakash & Jain 1979) and most of them are distributed in Peninsular India. In Kerala, this genus has so far been represented by 10 species (Nayar etal. 2006). The present new taxon from Kerala state is an additional species to the known species of the genus.

During floristic exploration in Ernakulam district of Kerala, India, the authors came across an interesting *Garnotia* from a moist rocky area of Variyam in Edamalayar Forest range. A critical examination revealed that the specimen was distinct from the hitherto known species of the genus. It is described and illustrated here as a new species.

Garnotia variyamensis Sunil, Naveen Kumar, & Sanilkumar, sp. nov. (**Figs. 1, 2**). TYPE: INDIA. KERALA: Ernakulam District, Edamalayar Forest Range, Variyam, 10°12.595'N &76°52.441'E, elev. ca. 794 m, 16 Oct 2013, *Sunil & Naveen Kumar 6193* (HOLOTYPE: CAL; ISOTYPE: MH).

Differs from all *G. courtallensis* in its lower glume shorter than the upper glume and lemma with geniculate, twisted awn, but differs by the large leaves, dissimilar spikelet pairs, awned glumes, and long-awned lemma of pedicelled spikelets.

Annual herbs. Culms 15–105 cm long, erect or geniculate, generally purplish; nodes villous, lower ones rooting. Leaf sheaths upto 8 cm long, slightly keeled, striate, tuberculate hairy, margins ciliate; ligules ca. 0.5 mm long, membranous; blades 4–15 × 0.8–2 cm, ovate-lanceolate or broadly lanceolate, base rounded to shallowly cordate, margins scabrid towards apex, apex acuminate, softly pubescent, articulated to sheath, membranous, lower side generally purplish, upper side greenish, collar hairy. Panicles 9–30 cm long, narrowly contracted; branches 2–4 per node in distant fascicles, 1.8–4 cm long, appressed to main axis, erect; rachis triquetrous to flattened, 1–1.3 mm broad, convex on back, scabrid on outer margins. Spikelets paired, dissimilar, one sessile and the other pedicelled, 3–3.3 × 0.5–0.6 mm, lanceolate, acuminate at apex, 1-flowered; callus shortly bearded

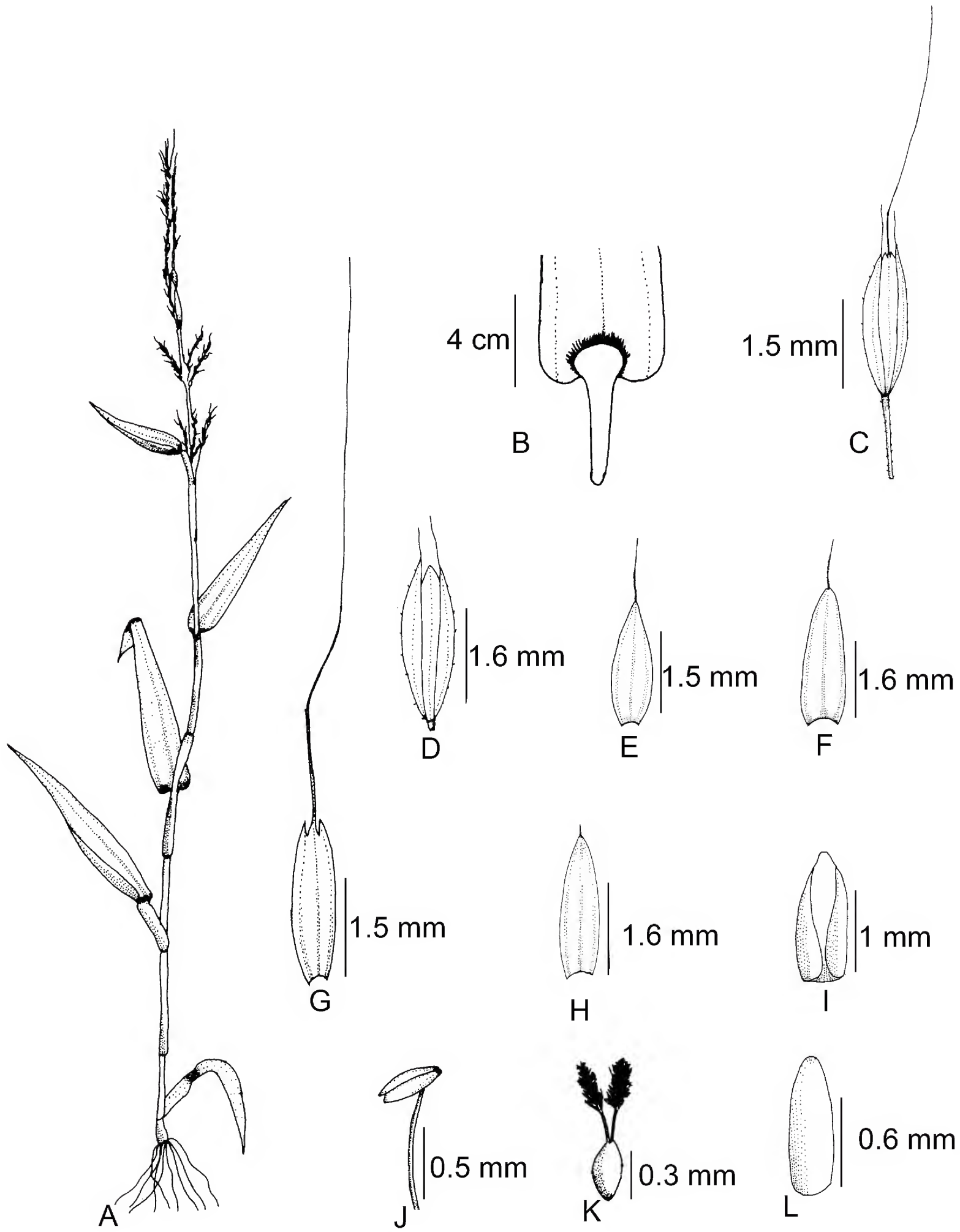


Fig. 1. *Garnotia variyamensis*. **A.** Habit; **B.** Base of Leaf; **C.** Single pedicelled spikelet; **D.** Sessile spikelet; **E.** Lower Glume; **F.** Upper Glume; **G.** Lemma of pedicelled spikelet; **H.** Lemma of sessile spikelet; **I.** Palea; **J.** Stamen; **K.** Pistil; **L.** Caryopsis. Based on *Sunil & Naveen Kumar 6193* (CAL).

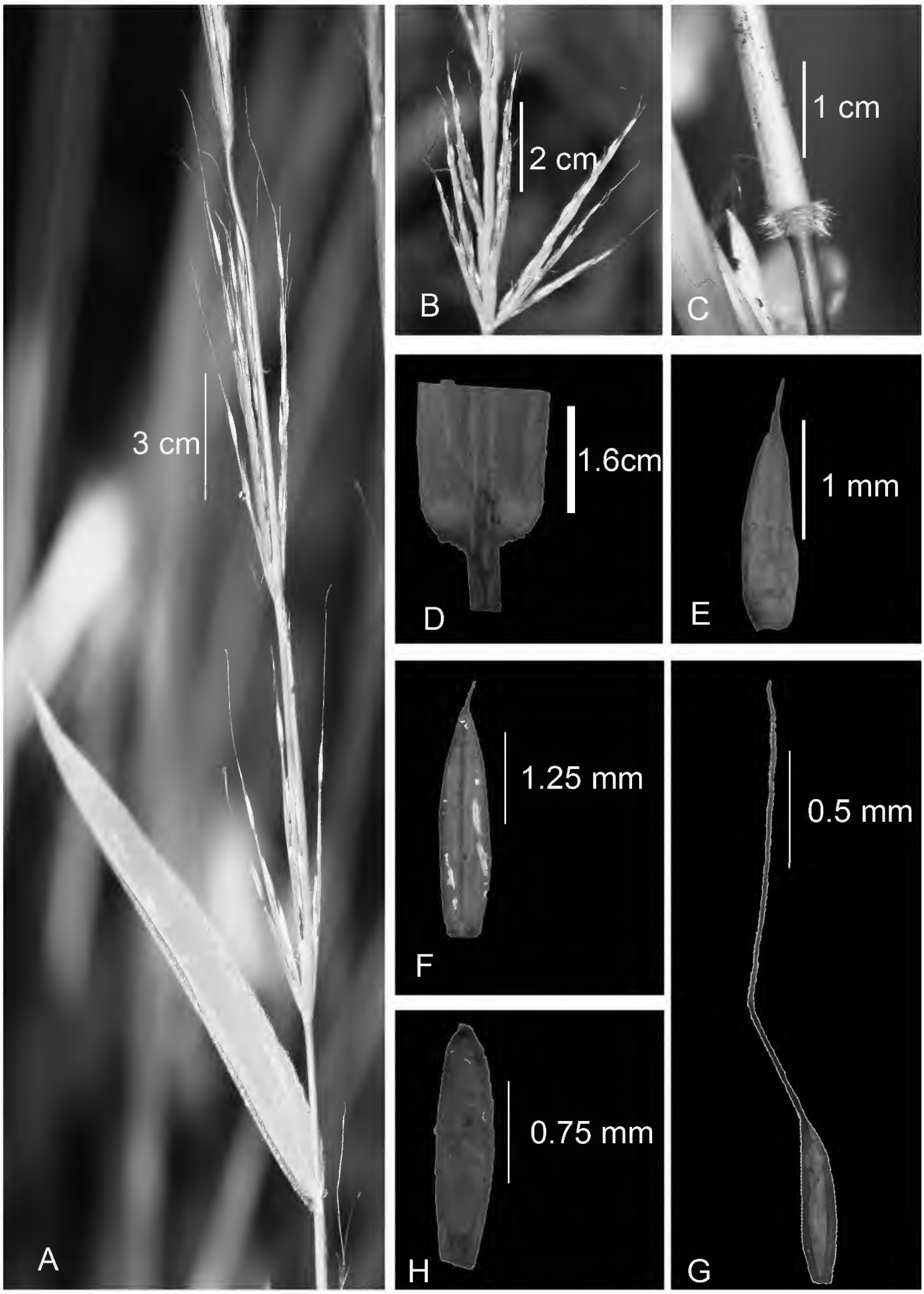


Fig. 2. *Garnotia variyamensis*. **A.** Habit; **B.** Inflorescence node showing racemes; **C.** Villous nodes; **D.** Leaf base; **E.** Lower glume; **F.** Upper glume; **G.** Lemma of pedicelled spikelet; **H.** Palea. Photos by C.N. Sunil (type collection: *Sunil & Naveen Kumar 6193* (CAL)).

or glabrous; pedicels 2–3 mm long, triquetrous, scabrid on margins. Sessile spikelets empty or male or rarely with rudimentary pistil, usually awnless; pedicelled spikelets bisexual, awned. Lower glume 2.6–2.9 × 0.5–0.6 mm, lanceolate, pale green, chartaceous, 3-nerved, lateral nerves scabrid, awned; awn upto 2.5 mm long, scabrid. Upper glume 3–3.2 × 0.5–0.6 mm, lanceolate, chartaceous, 3-nerved, lateral nerves scabrid, awned; awn upto 2 mm long, scabrid. Lemma 2.7–3 × 0.5–0.6 mm, lanceolate, margins in-rolled, acuminate and unawned or shortly aristate in sessile spikelets and shortly 2–lobed, awned from sinus in pedicelled spikelets, subcoriaceous, hyaline, 3-nerved; awns 11–14 mm long, geniculate, scabrid, column 2–2.5 mm long, dark brownish, twisted. Palea 2–2.2 × 0.4–0.5 mm, lanceolate, acute at apex, 2-nerved 2-keeled, hyaline. Stamens 3; anthers 0.5–0.7 mm long, oblong, cream-yellow.Ovary ca. 0.3 mm long, ellipsoid; style ca. 0.5 mm long, slender; stigma 0.5–0.7 mm long, purple, feathery. Lodicules 2, ca. 0.2 mm long, obovate, truncate. Caryopsis 1–1.2 × ca. 0.5 mm, oblong, pale brownish.

Flowering & Fruiting.—August–November.

Etymology.—The species is named after its type locality, Variyam, a tribal settlement within the Western Ghats.

Habitat and Ecology.—*Garnotia variyamensis* grows on wet exposed rocky grassland among mosses in association with *Tripogon sivarajanii* Sunil, *T. wightii* Hook.f., *Dimeria* spp., *Exacum sessile* L., *Impatiens viscosa* Bedd., and *Arundina graminifolia* (D. Don) Hochr.

Taxonomic note.—*Garnotia variyamensis* resembles *Garnotia courtallensis* Thwaites in its lower glume shorter than the upper glume and lemma with geniculate, twisted awn, but differs by the large leaves, dissimilar spikelet pairs, awned glumes, and long-awned lemma of pedicelled spikelets. Diagnostic morphological characters of *Garnotia variyamsis* and *Garnotia courtallensis* are provided in Table 1 and in the following key.

KEY TO SECTIONS OF *GARNOTIA* IN INDIA

1. Leaf blade and leaf sheath junction distinct, articulated; leaf sheath margins glabrous to ciliate but not woolly _____ Sect. 1. **Garnotia**
1. Leaf blade and leaf sheath junction indistinct, not articulated; leaf sheath margins woolly near base_____ Sect. 2. **Scoparia**

Sect. 1. **Garnotia**

1. Lemma with straight awn.
   2. Some spikelets awned, others awnless; spikelets upto 3 mm long _____ **G. micrantha** var. **micrantha**
   2. All spikelets awned; spikelets 3–5 mm long.
      3. Leaf- blades with a row of long hairs immediately behind the ligule _____ **G. fergusonii**
      3. Leaf- blades without a row of long hairs behind the ligule _____ **G. acutigluma**
1. Lemma with geniculate awn.
   4. Awn of lemma 16–26 mm long.
      5. Plants 5–25 cm long, usually growing with moss on tree trunks and rocks; lemma apex bifid, but the lobes not setaceous; panicle lax, few flowered, spreading _____ **G. arborum**
      5. Plants 20–50 cm long, not growing in moss on trees and rocks; lemma apex with narrow setaceous lobes; panicle contracted, many flowered _____ **G. polypogonoides**
   4. Awn of lemma 5–14 mm long.
      6. Awn of lemma without well- marked twisted column; apex of leaf- blades ending in a filiform tip _____ **G. arundinacea**
      6. Awn of lemma with well- marked twisted dark column; apex of leaf blades without filiform tips.
         7. Lower glume longer than the upper one or subequal.
            8. Awns geniculate at or near the base; leaf blades with a dense row of hairs immediately behind the ligule; collar densely hairy _____ **G. fergusonii**
            8. Awns geniculate well above the base; leaf- blades without a dense row of hairs behind the ligule; collar glabrous _____ **G. tenella**
         7. Lower glume shorter than the upper one.
            9. Leaf- blades 1–2 cm broad; spikelets dissimilar, one sessile and the other pedicelled, sessile spikelets male or empty, its lemma awnless; glumes awned; awns on lemma 11–14 mm long _____ **G. variyamensis**
            9. Leaf- blades 0.3–1 cm broad; spikelets similar, in unequally pedicelled pairs, all bisexual, its lemma awned; glumes awnless; awns on lemma 3–7 mm long _____ **G. courtallensis**

SECTION 2. *SCOPARIA*

1. Spikelets awnless; leaf-blades oblanceolate, flat _____ **G. exaristata**
1. Spikelets awned; leaf- blades linear, canaliculated, triangular in section.
   2. Awn geniculate at or near the base without well- marked twisted column _____ **G. scoparia**
   2. Awn geniculate well above the base with a well- marked twisted column.

TABLE 1. Diagnostic morphological characters of *Garnotia variyamensis* and *Garnotia courtallensis.*

Character	*Garnotia variyamensis*	*Garnotia courtallensis*
Culm	15–105 cm high.	10–60 cm high.
Leaf blades	4–15 cm long, 0.8–2 cm broad.	2–9 cm long, 0.2–1 cm broad.
Panicles	9–30 cm long, axis and branches very broad, triquetrous to flattened, convex on back.	4–15 cm long, axis and branches narrow and slender.
Panicle branches	Erect, more or less appressed to main axis.	Widely spreading or compacted.
Spikelets	Paired, dissimilar, one sessile and the other pedicelled, sessile spikelets empty or male, its lemma unawned	In unequally pedicelled pairs, similar, all bisexual and awned or lower ones of panicle unawned.
Glumes	With up to 2.5 mm long awn.	Acute, unawned.
Lemma	Of pedicelled spikelets shortly 2-lobed at apex and awned from sinus and that of sessile spikelet acuminate and unawned.	Entire or sometimes two lobed, acute, and awned from apex or rarely lower ones of panicle unawned.
Lemma awn	11–14 mm long.	3–7 mm long.

3. Spikelets 5–7.5 mm long; panicle 9–25 cm long, congested; awn of lemma 5–12 mm long _____ **G. schmidii**
3. Spikelets 3–5.5 mm long; panicle 28–60 cm long, not congested; awn of lemma 3.5–5 mm long _____ **G. elata**

Conservation status.—The distribution of *Garnotia variyamensis* showed that there were less than 245 mature individuals restricted to an area of 5km^2. By following IUCN criteria for assessing the status of rare and threatened plants (IUCN, 2001), *Garnotia variyamensis* is belonging to critically endangered (CR) category.

ACKNOWLEDGMENTS

The authors are grateful to the University Grants Commission, New Delhi, for financial assistance for the study. We express our thanks to the Kerala Forest Department for permitting collection of specimens. Sincere thanks are expressed to the manager, SNM College, Maliankara, for providing the facilities. Help rendered by K.D. Girija and other members of the Department of Botany, SNM College, Maliankara, are also thankfully acknowledged. We greatly appreciate careful reviews by Alok Chorghe, Jeffery Saarela, and an anonymous reviewer.

REFERENCES

BOR, N.L. 1960. The grasses of Burma, Ceylon, India and Pakistan (excluding Bambuseae). Pergamon Press, London, Oxford, New York, Paris.

GOULD, F.W. 1972. A systematic treatment of *Garnotia* (Gramineae). Kew Bull. 27(3):515–562

IUCN. 2001. IUCN Red list categories and criteria (version 3.1). IUCN, Gland, Switzerland and Cambridge, U.K.

MABBERLEY, D.J. 2008.Mabberley's plant-book: A portable dictionary of plants, their classification and uses. Third Edition. Cambridge University Press, Cambridge, U.K.

NAYAR, T.S., A. RASIYABEEGAM, N.MOHANAN, & G. RAJKUMAR. 2006. Flowering plants of Kerala. Tropical Botanical Garden and Research Institute, Palode, Thiruvananthapuram, India.

PRAKASH, V. & S.K. JAIN.1979. Poaceae: Garnotieae. In: Fasc. Fl. India 3:1–16, Botanical Survey of India, Calcutta, India.

BOOK REVIEW

Kenneth D. Heil, Steve L. O'Kane, Jr., Linda Mary Reeves, and Arnold Clifford. 2013. **Flora of the Four Corners Region: Vascular Plants of the San Juan River Drainage. Arizona, Colorado, New Mexico, and Utah.** (ISBN-13: 978-1-930723-84-9, hbk). Missouri Botanical Garden Press, P.O. Box 299, Saint Louis, Missouri 63166-0299, U.S.A. (**Orders:** www.mbgpress.info, orders@mbgpress.org, 1-877-271-1930). $72.00, 1098 pp., 8.5" × 11.25".

There is always an element of hubris inherent in any attempt at compiling a flora for a region. Plants, after all, grow to suit their own needs, and trying to slot such diversity into neat human-friendly delineations requires a powerful faith. How much more true is this when confronting a landscape as wild and varied as the Four Corners region?

And yet, the collaborative effort that is *Flora of the Four Corners Region* has kept the faith and created a remarkable text for a magnificent but too-often neglected region. As the authors themselves recognized, the Four Corners region was often a marginal element of other floras that were based on political, rather than eco-regional, boundaries.

The argument in favor of floras based on ecoregions is a cogent one. After all, location may be the one definitive fact attributable to a specimen of unknown origin. By limiting a flora to one region, the taxa treated can likewise be limited to only those one is likely to encounter in a particular area. From the user's perspective, it can be tremendously frustrating to be comparing a specimen to descriptions of species occurring hundreds of miles distant.

From the perspective of natural history, eco-regional floras allow a more comprehensive treatment of organisms that share a similar region, if not similar habitats. The likelihood of gene flow decreases sharply as linear distance increases. Even though the Four Corners region contains over 2000 m of elevational variation, the region is still united by aridity and a high (average) elevation. Individual populations have many opportunities to meet and mingle under these conditions. The eco-regional approach of *Flora of the Four Corners* allows a systematic account of this diversity considered in context.

That intensity of focus is the real strength of this work: scholarship backed by extensive field work and herbarium studies to provide real heft to the keys and descriptions contained within. The treatments show this attention to detail. I am not qualified to review every key presented, but I have been spending an inordinate amount of time focusing on the genus *Astragalus* in New Mexico, and I am, by now, intimately familiar with the keys provided by Barneby in his seminal *Atlas of North American Astragalus* (Memoirs of the New York Botanic Garden, vol. 13, 1964). I have also spent significant time with the *Flora of New Mexico* by Martin and Hutchins, and *Flora Neomexicana* by Allred and Ivey. I will not attempt direct comparisons, since each covers such diverse geographic regions. I can, however, say that *Flora of the Four Corners Region* takes an approach to the genus that offers more than a simple pruning of Barneby's more geographically comprehensive work. In other words, I can attest that this work offers a new and interesting approach to at least one diverse and difficult taxon.

Finally, the *Flora* includes many notes of ethnobotanical interest. Other works, of course, will offer much greater depth on this subject, but it is profoundly refreshing to see traditional knowledge treated with respect and inclusion. The authors of this work rightly recognize that they are the most recent in a long history of people interacting with the flora of this region.

My only wish for the *Flora* is that more illustrations had been included. As a researcher working primarily with herbarium specimens, many of them more than three decades old, simple line drawings illustrating the fine points of stipules, reproductive structures, and hair morphology would be of tremendous use. I recognize that this volume was already decades in the making, and the inclusion of monochromatic line drawings would have been a significant additional complication. Nevertheless, those drawings could be the single most effective means of elucidating an identification.

Illustrations notwithstanding, however, this *Flora of the Four Corners Region* is a remarkable and extremely useful guide to the plants of some of the most rugged and beautiful terrain in the United States. The authors have created a classic that will remain the definitive work for a long time to come.—*Brian Witte, PhD, Research Associate, Botanical Research Institute of Texas, Fort Worth, Texas, U.S.A.*

TRIPOGON MALABARICA (POACEAE: CHLORIDOIDEAE: CHLORIDEAE: TRIPOGONINAE), A NEW SPECIES FROM KERALA, INDIA

Thoiba Kottekkattu and A.K. Pradeep

Department of Botany, University of Calicut
Kerala 673 635, INDIA
thoibakk@gmail.com; akpradeep1@rediffmail.com

ABSTRACT

A new species of Poaceae, **Tripogon malabarica** Thoiba & Pradeep from Malabar Wildlife Sanctuary, Western Ghats of Kerala, India, is described and illustrated.

KEY WORDS: *Tripogon*, Poaceae, new species, Western Ghats, India.

RESUMEN

Se describe e ilustra una nueva especie de Poaceae, **Tripogon malabarica** Thoiba & Pradeep de los Malabar Wildlife Sanctuary, Western Ghats de Kerala, India.

INTRODUCTION

The genus *Tripogon* Roem. & Schult. (Poaceae: Chloridoideae: Chlorideae: Tripogoninae) is represented by 44 species distributed in Africa, Australia, and Temperate and Tropical Asia (Clayton et al. 2006). The genus is known to have 20 species in India, which includes the recently described four new species (Murugesan & Balasubramaniam 2008; Newmaster et al. 2008; Kabeer et al. 2009; Chorghe et al. 2013). With the addition of the present species, the total number of species in India has become 21.

The authors, during the course of revisionary studies on Eragrostidinae s.l. in South India came across an interesting population of *Tripogon* growing along steep granitic cliffs in Malabar Wildlife Sanctuary, Kakkayam along the Western Ghats of Kerala, in South India. Critical studies revealed it to be an undescribed species of *Tripogon,* though they showed some similarities with *T. lisboae* and *T. vellarianus* (Table 1).

TAXONOMIC TREATMENT

Tripogon malabarica Thoiba & Pradeep, sp. nov. (**Figs. 1–2**). TYPE: INDIA. KERALA. Kozhikode Dt.: Malabar Wildlife Sanctuary, Kakkayam, 990 m elev., 11°33.037'N, 075°55.024'E, 19 Sep 2013, *Thoiba Kottekkattu 134436* (HOLOTYPE: BRIT; ISOTYPES: CALI, K, MH).

Tripogon malabarica is closely allied to *T. lisboae* Stapf and *T. vellarianus* Pradeep but differs in having linear, coriaceous, villous leaf sheaths; 13–14 mm long spikelets with 4–7 florets; lemma with straight or geniculate, scabrid awn and keeled palea with a subulate apex.

Tufted perennial herb. Culms 25–65 cm high; nodes glabrous. Leaf blades 30–70 × 02 – 0.8 cm, linear-lanceolate, margins slightly scabridulous or scabrid, upper surface pubescent with short white papillose hairs, glabrous abaxially. Leaf sheaths linear-lanceolate, coriaceous, villous adaxially, 10–18 cm long, apex pubescent with a tuft of 2.5–3.5 mm long hairs at both ends; ligules indistinct. Racemes terminal, 15–40 cm long, with 30–55 spikelets; rachis stout, glabrous. Spikelets 13–14 mm long, linear, distant, dorsiventrally flattened, 4–7-flowered; callus bearded. Lower glumes 2.5–4 × 1–1.5 mm, coriaceous, ovate-lanceolate, 1-keeled, 1-nerved, keels slightly scabrid, with acuminate apex. Upper glumes 4.5–6 × 1–1.5 mm, lanceolate, coriaceous, 1-keeled, scabrid, 3-nerved, acute at apex. Lemmas 5 × 1.5–2 mm, ovate-lanceolate, 3-nerved, slightly keeled, scabrid; 1-awned, 3 mm long, scabrid, sometimes slightly geniculate towards apex. Paleas 3–5 × 1–1.5 mm, obovate, hyaline, 2-keeled, ciliate, apex subulate, rachilla 1mm long, glabrous. Lodicules 2, c. 0.25–0.5 mm long, truncate apex coarsely 3-toothed. Stamens 3; anthers 1.5–2 mm long, oblong; filaments 1mm long, slender, glabrous. Ovary 0.5–0.75 × 0.25–0.5 mm, obovate, styles 2, slender, hyaline, 0.5–0.75 mm long; stigma 0.75 mm long, plumose, creamy white. Grain not seen.

TABLE 1. Diagnostic morphological differences between *Tripogon lisboae, Tripogon vellarianus,* and *Tripogon malabarica.*

	Tripogon lisboae	*Tripogon vellarianus*	*Tripogon malabarica*
Culms	20–60 cm high	30–90 cm high	25–65 cm high
Ligule	an eciliate membrane	indistinct or absent	indistinct, a fringe of hairs at the ends of leaf-sheath; hairs 2–3.5 mm long
Leaf-sheath	linear, flat or convolute, rigid and glabrous	linear, closely clasping, rigid and glabrous	linear-lanceolate, coriaceous, villous adaxially
Racemes	7–25 cm long	30–40 cm long	15–40 cm long
Spikelets	3–12-flowered	8–10-flowered	4–7-flowered
Lower glume	asymmetrical, membranous, 1 mm long, scabrid	symmetrical, membranous, 4–5 mm long, glabrous	symmetrical, coriaceous, 1.5–4 mm long scabrid
Upper glume	elliptic, 3–3.5 mm long, subcoriaceous,1-nerved, slightly scabrid, mucronate at apex	elliptic-lanceolate, 6–7.5 mm long, membranous, 3-nerved, glabrous, acute at apex	lanceolate, 2–6 mm long, coriaceous, 3-nerved, scaberulose, acute at apex
Lemma	3–5 mm long, 2-fid, 1-awned, awns 1–2 mm long, glabrous, straight	5–10 mm long (excluding awn), 2-fid, 1- awned, awns 3 mm long, glabrous, straight	4–5 mm long (excluding awn), 2-fid, 1-awned, awns 3 mm long, scabrid, straight or geniculate at maturity
Palea	2–4 mm long, oblong, keels scaberulose, obtuse at apex	4–8 mm long, narrowly elliptic, winged, keels puberulous, acute at apex	2–4.5 mm long, oblong-lanceolate, keels scaberulose, subulate at apex
Caryopsis	narrowly oblong, terete	not seen	not seen

Distribution.—Presently *Tripogon malabarica* is known only from the Malabar Wildlife Sanctuary, Kakkayam in Kozhikode district of Kerala.

Ecology and Phenology.—This species grows from 950–1500 m elevation on steep granitic cliffs (Fig. 2), road cuts and wet rocky hillsides and found growing in association with *Chlorophytum malabaricum* Baker, *Pouzolzia auriculata* Wight, *P. bennetiana* Wight, *Impatiens scapiflora* Heyne ex Roxb., *I. gardneriana* Wight, *Kleinia grandiflora* (Wall. ex DC.) Rani, *Themeda triandra* Forssk., and *Panicum* spp.; flowering late July to November.

KEY TO SPECIES OF *TRIPOGON* IN SOUTH INDIA

1. Culms thickened below by the persistent leaf-sheaths; leaves < 2 cm long, equitant, rigid, pungent _____ **T. pungens** C.E.C. Fisch.
1. Culms not thickened below by the persistent leaf sheaths; leaves > 2.5 cm long, not equitant, not rigid or pungent.
   2. Lemma cleft at apex into 2 lobes, awned in the cleft; lobes awned or not.
      3. Central awn of the lemma flexuous, capillary, and several times as long as lemma _____ **T. capillatus** Jaub. & Spach
      3. Central awn of the lemma straight or curved, not more than twice as long as the lemma.
         4. Annuals; rachilla internodes 2mm; lemma apex 3-awned _____ **T. cope** Newmaster, V. Balas., Murug. & Ragup.
         4. Perennials; rachilla internodes 1mm; lemma apex 1-awned.
            5. Upper glumes 5.5–7 mm long; awns of the lemmas 6–8 mm long, straight or curved _____ **T. wightii** Hook.
            5. Upper glumes 8–9.5 mm long; awns of the lemma 10.5–12 mm long, always straight _____ **T. velliangiriensis** Murug. & V. Balas.
               6. Perennials with wiry roots forming tufts; leaf blade glabrous or scabrid; lower glumes asymmetrical.
                  7. Leaves and culms glaucous, leaves 5–20 cm long, involute, filiform; ligule very short but definite, ciliate _____ **T. jacquemontii** Stapf
                  7. Leaves and culms not glaucous, leaves 30–60 cm long, 4–8 mm wide, usually flat, sometimes rolled; ligule obsolete _____ **T. lisboae** Stapf
               6. Perennials with fibrous roots, forming a close turf; leaf blade glabrous or villous adaxially; lower glumes symmetrical or asymmetrical.
                  8. Leaves flat, ligules indistinct; lower glume symmetrical.
                     9. Ligules indistinct, a fringe of hairs at the ends of leaf sheath; spikelets with 4–7 florets; lemma 4–5 mm long; keels of palea scaberulose, subulate at apex _____ **T. malabarica** Thoiba & Pradeep
                     9. Ligules indistinct or absent; spikelets with 8–10 florets; lemma 5–10 mm long; keels of palea puberulous, acute at apex _____ **T. vellarianus** Pradeep
                  8. Leaves flat to convolute, ligules membranous, lower glume asymmetrical.
                     10. Ligules membranous; lemma base glabrous, median awn as long as or shorter than the lemma; inflorescence 20–45 cm long; spikelets with 5–8 florets _____ **T. sivarajanii** Sunil

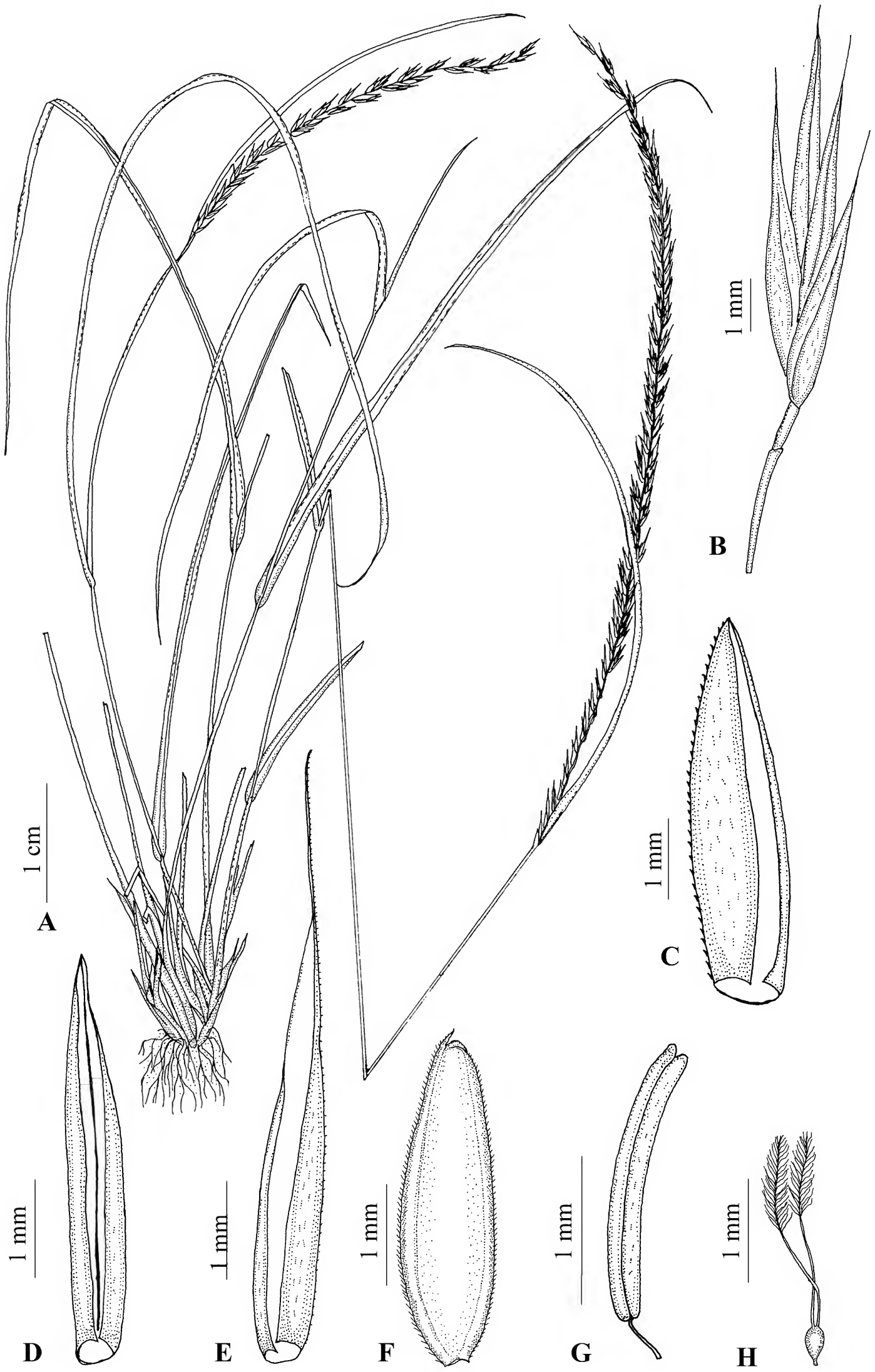


Fig. 1. *Tripogon malabarica* Thoiba & Pradeep. **A.** Habit. **B.** Spikelet. **C.** Lower glume. **D.** Upper glume. **E.** Lemma. **F.** Palea. **G.** Stamen. **H.** Pistil. A–H, drawn from holotype.

Fig. 2. Steep granitic cliffs at Malabar Wildlife Sanctuary, Kakkayam, Kozhikode, the natural habitat of *Tripogon malabarica* Thoiba & Pradeep. Photo taken by Thoiba Kottekkattu, 21 Aug 2014.

10. Ligules ciliate, membranous; lemma base bearded, median awn 1.5 times longer than lemma; inflorescence 15–20 cm long; spikelets with 9–10 florets _____ **T. tirumalae** Chorghe, Rasingam, Prasanna, & Sankara Rao

2. Lemma cleft at apex into 4 or 6 lobes or with a definite lobes between each lateral awn and central; outer lobes if present awned or not.
   11. Leaves hairy; ligules inconspicuous; keels of the palea scabrid _____ **T. bromoides** Roth
   11. Leaves glabrous or hairy; ligules conspicuous, thin, membranous; keels of the palea ciliate or not.
      12. Lemma cleft at apex into 6- lobes.
         13. Upper glume 7–9 mm long, notched at apex with small awn between; keels of palea ciliate; stamens 1.3–2 mm long _____ **T. anantaswamianus** Sreek., V.J. Nair, & N.C. Nair
         13. Upper glume 3 mm long, acute at apex, deeply 2-lobed with arista 0.5 mm long; keels of palea not ciliate; stamens upto 0.8 mm long _____ **T. borii** Kabeer, V.J. Nair, & G.V.S. Murthy
      12. Lemma cleft at the apex into 4- lobes.
         14. Culms 10–20 cm tall; lower glumes shallowly lobed on one-side above the middle; central lobes of the lemmas ovate-acute _____ **T. narayanae** Sreek., V.J. Nair, & N.C. Nair
         14. Culms 24–70 cm tall; lower glume deeply lobed on one-side below the middle; central lobes of the lemmas lanceolate _____ **T. ravianus** Sunil & Pradeep

ACKNOWLEDGMENTS

We would like to thank Kerala Forest Department for permission to do field studies at Malabar Wildlife Sanctuary; University of Calicut for providing financial support; and two anonymous reviewers for comments that improved the manuscript.

REFERENCES

Chorghe, A., L. Rasingam, P.V. Prasanna, & M.S. Rao. 2013. *Tripogon tirumalae* (Poaceae), a new species from the Seshachalam Hills of Andhra Pradesh, India. Phytotaxa 131(1):17–22.

Clayton, W.D., M.S. Vorontsova, K.T. Harman, & H. Williamson. 2006 onwards. GrassBase–the online world grass flora. Available at http://www.kew.org/data/grass.db.html. Accessed 10 Aug 2013.

Kabeer, K.A.A., V.J. Nair, & G.V.S. Murthy. 2009. *Tripogon borii*—a grass species new to science from India. Bull. Bot. Surv. India 50:115–118.

Murugesan, M. & V. Balasubramaniam. 2008. *Tripogon velliangiriensis* (Poaceae)—a new species from Tamil Nadu, India. Indian J. Forest. 31:109–111.

Newmaster, S.G., V. Balasubramaniam, M. Murugesan, & S. Ragupathy. 2008. *Tripogon cope* (Poaceae: Chloridoideae), a new species supported by morphometric analysis and a synopsis of *Tripogon* in India. Syst. Bot. 33:695–701.

BOOK NOTICE

Richard B. Taylor. 2014. **Common Woody Plants & Cacti of South Texas.** (ISBN-13: 978-0-292-75652-6, flexbound). University of Texas Press, PO Box 7819, Austin, Texas 78713-7819, U.S.A. (**Orders:** www.utexaspress.com, 1-800-252-3206). $22.95, 152 pp., 117 color photos, illus. glossary, bib., index, 4.5" × 7.25".

This is a field guide for the identification of and critical information related to the values and uses of the 50 most common trees, shrubs, cacti, yucca, and succulents of the South Texas "brush country". It was written by a retired Texas Parks & Wildlife Department biologist. Its primary focus is wildlife, but it includes a great deal of valuable information about resource management and values for a variety of other concerns.

The book's compact size makes it an ideal reference to take along on hikes, field trips, and explorations. The 50 plants selected for inclusion in the book are the most significant of the more than 281 woody species and 32 species of cacti, yucca, and succulents found in the region. They represent more than 75% of the total tree, shrub, and cacti component of South Texas.

The book begins with a historical perspective on the social, cultural, and economic factors that have influenced the plant communities, ranching enterprises, and wildlife habits of South Texas. That is followed by a description of the history of brush management activities and efforts in recent history. Also included in the introductory section is general guidance on habitat appraisal and evaluation techniques.

The **Quick Key** for plant identification is one of the most useful keys I have seen for woody plants. Species are quickly grouped into three broad categories: (1) thorned woody plants, (2) thornless woody plants, and (3) cacti, yucca, and succulent plants. From there each broad category is further subdivided and systematically narrowed down using easily identified characteristics. For example the thorned woody plants are subdivided into two categories: (1) those with straight thorns and (2) those with curved thorns. Thornless plants are placed into subcategories based on growth form (tree-like or shrub-like). As the user progresses through the Quick Key using the recognizable characteristics to limit the possibilities, even relatively inexperienced botanists can easily narrow the list of potential species until finally the user has a positive identification, or at least a very small group of potential plants.

Following the quick key are narrative descriptions of each of the 50 plants. Species are listed by scientific name but also include one or more common names (including Spanish common names). The descriptions are well-written, easy to understand and very informative. They are accompanied by at least one, and often two or more, color photographs showing the plant in its natural habitat. The descriptions and pictures help the user verify the identity of each plant. The narrative description of each species also includes a value rating of the plant for wildlife, livestock, and other uses.

In addition to the typical information listed above, this guide also includes at the end of each narrative description the crude protein content of the leaves and/or fruits of the plant during each season of the year. This is critical information for wildlife biologists, ranch managers, landowners, and others who depend on these browse plants to provide the nutritional needs of wildlife and livestock. The information is a valuable reference source to aid in wildlife management.

Appendix I is a table showing the habitat values (food, cover, nesting, roosting, water, etc.) that the included plants provide for the following categories of wildlife: game birds, song birds, insects, small mammals, deer, and reptiles. Appendix II is a table listing the palatability and browse preference of each plant species for white-tailed deer. Plants are described as 1st choice, 2nd choice, 3rd choice, etc. Appendix III lists the percentages of crude protein, digestible protein, and digestible dry matter for each plant across the seasons. And Appendix IV is a listing of the common names and scientific names of every plant, vertebrate, and invertebrate mentioned in the book. A two-page illustrated glossary, a bibliography, and an index round out the book's end matter.

This field guide is an invaluable resource for wildlife managers, biologists, ranchers, conservationists, amateur botanists, students, and anyone else interested in the vegetation of the South Texas "brush country."—*Dan Caudle, Independent Grassland Consultant, Weatherford, Texas, U.S.A.*

WANDERSONG (RUBIACEAE), A NEW GENUS FROM THE GREATER ANTILLES

David W. Taylor

Department of Biology
University of Portland
Swindells Hall 108, MSC 163
5000 N. Willamette Blvd.
Portland, Oregon 97203, U.S.A.
taylorda@up.edu

ABSTRACT

A revision of *Chione* DC. (Rubiaceae) has excluded two species, *C. exserta* (DC.) Urb. and *C. seminervis* Urb. & Ekman, from the genus on the basis of morphology. The designation *Colleteria* D.W. Taylor was proposed to house these species, but it was invalidly published. The new genus **Wandersong** D.W. Taylor is here erected to accommodate these two species. The new combinations **Wandersong exserta** (DC.) D.W. Taylor and **Wandersong seminervis** (Urb. & Ekman) D.W. Taylor are here effected under this new generic name. The new genus name *Wandersong* D.W. Taylor honors two Andersons, Dr. Gregory J. Anderson and Dr. William R. Anderson, for their outstanding and influential achievements in the field of botany. The name *Wandersong* is constructed with the surname Anderson shared between the first initials of these two botanists.

RESUMEN

Una revisión taxonómica de *Chione* DC. (Rubiaceae) ha excluido dos especies, *C. exserta* (DC.) Urb. y *C. seminervis* Urb. & Ekman, del género debido a su morfología. Se propuso la designación *Colleteria* D.W. Taylor para acomodar estas especies, pero su publicación fue inválida. Aquí se erige el nuevo género **Wandersong** D.W. Taylor para acomodar estas dos especies. Aquí también se efectúan las nuevas combinaciones **Wandersong exserta** (DC.) D.W. Taylor y **Wandersong seminervis** (Urb. & Ekman) D.W. Taylor. El nombre del nuevo género, *Wandersong* D.W. Taylor, honra a dos botánicos con el apellido de Anderson, Dr. Gregory J. Anderson y Dr. William R. Anderson, por sus logros tan sobresalientes y sus investigaciones sumamente influyentes en el campo profesional de la Botánica. El nombre *Wandersong* está construido con el apellido Anderson compartido entre las primeras iniciales de los nombres de estos dos botánicos.

KEY WORDS: *Wandersong* D.W. Taylor, *Wandersong exserta* (DC.) D.W. Taylor, *Wandersong seminervis* (Urb. & Ekman) D.W. Taylor, *Colleteria* D.W. Taylor, *Colleteria exserta* (DC.) D.W. Taylor, *Colleteria seminervis* (Urb. & Ekman) D.W. Taylor, *Chione exserta* (DC.) Urb., *Chione seminervis* Urb. & Ekman, Dr. William R. Anderson, Dr. Gregory J. Anderson.

During a taxonomic revision of the genus *Chione* DC. (Rubiaceae), two species, *C. exserta* (DC.) Urb. and *C. seminervis* Urb. & Ekman, were found to be morphologically outside the circumscription of the genus, and were not referable to any existing genus (Taylor 2003a). The designation *Colleteria* D.W. Taylor was proposed to house these two species (Taylor 2003b), but inadvertently used a morphological term, which is not permitted (Article 20.2 of the International Code of Nomenclature for algae, fungi, and plants (Melbourne Code); International Association for Plant Taxonomy website; http://www.iapt-taxon.org/nomen/main.php?page=art20; website accessed June 4, 2014). The term "colleteria" is the plural of "colleterium," a technical entomological term for "an accessory glandular structure of oviduct which manufactures and secretes viscid material used to cement eggs together" (Gordh & Headrick 2011). Thus, the designation *Colleteria* was not validly published under Art. 32.1. A new genus name, *Wandersong* D.W. Taylor, is here published to accommodate *Chione exserta* and *Chione seminervis*. The new combinations *Wandersong exserta* (DC.) D.W. Taylor and *Wandersong seminervis* (Urb. & Ekman) D.W. Taylor are here effected under this new generic name.

The new genus name *Wandersong* D.W. Taylor honors two Andersons, Dr. Gregory J. Anderson and Dr. William R. Anderson, for their outstanding and influential achievements in the field of botany. The name *Wandersong* is constructed with the surname Anderson shared between the first initials of these two botanists. The author wishes to honor these two botanists specifically because of their extraordinary mentorship, first in their roles as his undergraduate and Ph.D. advisors, respectively, at the University of Connecticut and the University

of Michigan, and then later as professional colleagues. Both of these Andersons, through their great dedication, generosity, and insight, have been instrumental in shaping the author's career as a botanist.

The three nomenclatural changes proposed here are therefore:

1. Wandersong D.W. Taylor, gen. nov. TYPE: *Wandersong exserta* (DC.) D.W. Taylor.

A full description and diagnosis of this new genus is found under the designation *Colleteria* D.W. Taylor (2003b:203).

The genus *Wandersong* D.W. Taylor can be diagnosed by a combination of characters, some of which are: colleters present consistently on adaxial face of stipules and often on adaxial face of calyx, corolla lobes imbricate in bud, anthers inserted at or below middle of corolla tube, fruit with two pyrenes, the pyrenes adaxially concave, abaxially convex and ridged, with marginal germination slits extending from apex to middle, each pyrene with one locule, ovules solitary and pendulous in locules. *Chione* is distinguished from *Wandersong* by many vegetative and reproductive features (see Taylor 2003a and 2003b), including the absence of colleters and each fruit having a single, sclerenchymatized pyrene enclosing two locules. The fruit type of *Wandersong*, including pyrene architecture, is similar to that reported for some members of the Psychotrieae (Taylor 1989, 1996; Andersson 2002), but *Wandersong* is distinct in having apical placentation.

2. Wandersong exserta (DC.) D.W. Taylor, comb. nov. BASIONYM: *Psychotria exserta* DC., Prodr. 4:517. 1830. *Chione exserta* (DC.) Urb., Symb. antill. 8:675. 1921. *Colleteria exserta* (DC.) D.W. Taylor, Syst. & Geogr. Pl. 73(2):204. 2003, nom. inval. TYPE: DOMINICAN REPUBLIC: Santo Domingo, *Bertero s.n.* (HOLOTYPE: G-DC, not seen, microfiche, photo: MO).

Taylor (2003b) has written a detailed description of this species, under the designation *Colleteria exserta* (DC.) D.W. Taylor.

3. Wandersong seminervis (Urb. & Ekman) D.W. Taylor, comb. nov. BASIONYM: *Chione seminervis* Urb. & Ekman, Ark. Bot. 20A(5):59. 1926. *Colleteria seminervis* (Urb. & Ekman) D.W. Taylor, Syst. & Geogr. Pl. 73(2):206. 2003, nom. inval. TYPE: HAITI. MASSIF DE LA SELLE: Nouvelle Touraine, high ridge towards Morne La Visite, (Pétionville, Roberjat), in forest on eruptive, ca. 1700 m, *Ekman H1537* (LECTOTYPE, here designated because holotype at B destroyed: S; ISOTYPES: F, G, GH, S, US).

Taylor (2003b) has written a detailed description of this species, under the designation *Colleteria seminervis* (Urb. & Ekman) D.W. Taylor.

ACKNOWLEDGMENTS

The author wishes to express his appreciation to Christiane Anderson, Mona Anderson, Rev. Robert Antonelli, Fred Barrie, Roy Gereau, Joseph Kirkbride, Jr., Barney Lipscomb, Charlotte Taylor, and an anonymous reviewer for their very kind help. The author is extremely grateful to both Gregory J. Anderson and William R. Anderson for their countless thoughtful contributions to his life.

REFERENCES

ANDERSSON, L. 2002. Relationships and generic circumscriptions in the *Psychotria* complex (Rubiaceae, Psychotrieae). Syst. & Geogr. Pl. 72:167–202.

GORDH, G. & D. HEADRICK. 2011. A dictionary of entomology, 2nd edition, p. 333. CABI, Cambridge, Massachusetts, U.S.A.

INTERNATIONAL CODE OF NOMENCLATURE FOR ALGAE, FUNGI, AND PLANTS (MELBOURNE CODE). 2012. Available at the International Association for Plant Taxonomy website; http://www.iapttaxon.org/nomen/main.php?page=art20. Accessed June 4, 2014.

TAYLOR, C.M. 1989. Revision of *Palicourea* (Rubiaceae) in Mexico and Central America. Syst. Bot. Monogr. 26:1–102.

TAYLOR, C.M. 1996. Overview of the Psychotrieae (Rubiaceae) in the Neotropics. In: E. Robbrecht, C. Puff & E. Smets, eds. Second international Rubiaceae conference proceedings. Opera Bot. Belg. 7:261–270.

TAYLOR, D.W. 2003a. A taxonomic revision of the genus *Chione* (Rubiaceae). Syst. & Geogr. Pl. 73(2):171–198.

TAYLOR, D.W. 2003b. *Colleteria* (Rubiaceae), a new genus from the Caribbean. Syst. & Geogr. Pl. 73(2):199–208.

VARIABILITY OF VEGETATIVE FLUSH COLORS IN *ZAMIA* (CYCADALES)

Claudia Calonje

Montgomery Botanical Center
11901 Old Cutler Rd.
Coral Gables, Florida, 33156 U.S.A.

Lindy Knowles

Bahamas National Trust
Nassau, THE BAHAMAS

Michael Calonje

Montgomery Botanical Center
11901 Old Cutler Rd.
Coral Gables, Florida, 33156 U.S.A.
and Florida International University
Miami, Florida 33174, U.S.A.
michaelc@montgomerybotanical.org

Chad Husby

Montgomery Botanical Center
11901 Old Cutler Rd.
Coral Gables, Florida, 33156 U.S.A.

ABSTRACT

The color of new vegetative leaf flushes can vary among species of cycads. It is often used as a diagnostic character in taxonomy and is one of the most appreciated features of the group in ornamental horticulture. However, little is understood about the variability of flush color within species and wild populations. This paper discusses variability in flush color within the genus *Zamia* and uses a comprehensive ex situ conservation collection of three *Zamia* species (*Z. angustifolia*, *Z. integrifolia*, and *Z. lucayana*) collected from six islands in The Bahamas (Abaco, Andros, New Providence, Eleuthera, Grand Bahama, and Long Island) as a case study to examine this variability between species, between and within populations, and within progeny of individual mother plants. Flush color was found to be exclusively brown in *Z. angustifolia* and green in *Z. lucayana*. For *Zamia integrifolia*, flush color was exclusively green in seedlings derived from Abaco, Grand Bahama, and Eleuthera, but was variable in seedlings derived from Andros in New Providence, where both colors were present. On these two islands, flush color varied between and within populations, as well as within progeny of individual mother plants.

The observed variability in flush colors suggests that a large number of *in situ* observations from multiple plants in several populations would be required to determine if a particular flush color character state is fixed and therefore useful as a diagnostic character. This can only be done through long term study of *in situ* populations, as leaf production is typically seasonal and is not necessarily synchronized or universal within wild populations. Therefore, we recommend against the use of flush color as a diagnostic character in cycad taxonomy.

RESUMEN

El color de las hojas nuevas de cicadas puede variar entre diferentes especies. A menudo se utiliza como carácter diagnóstico en taxonomía y es una de las características más apreciadas del grupo en horticultura ornamental. Sin embargo, se sabe muy poco sobre la variabilidad en el color de hojas nuevas dentro de las especies y poblaciones silvestres. En este artículo se discute la variabilidad en el color de hojas nuevas dentro del género *Zamia* y se usa una colección extensa de conservación ex situ de tres especies de *Zamia* (*Z. angustifolia*, *Z. integrifolia*, y *Z. lucayana*) colectadas de seis islas de las Bahamas (Abaco, Andros, New Providence, Eleuthera, Grand Bahama, y Long Island) como un estudio de caso para examinar esta variabilidad entre especies, en y entre poblaciones, y en descendientes de la misma planta madre. El color de hojas nuevas fue exclusivamente café en Z. angustifolia y verde en Z. lucayana. Para *Zamia integrifolia*, el color de hojas nuevas fue exclusivamente verde en plántulas derivadas de Abaco, Grand Bahama, y Eleuthera, pero variables en plántulas de Andros y New Providence, donde ambos colores estaban presentes. En estas dos islas, el color de hojas nuevas variaba en y entre poblaciones así como también entre descendientes de una misma planta madre.

La variabilidad observada sugiere que un número grande de observaciones *in situ* de múltiples plantas en múltiples poblaciones serían requeridas para determinar si el estado de carácter para el color de hojas nuevas es un carácter fijo que pueda servir como carácter diagnóstico. Esto solo se podría hacer a través de estudios de poblaciones *in situ* a largo plazo porque la producción de hoja nueva ocurre por temporadas y no necesariamente está sincronizado o es universal en las poblaciones silvestres. Por estas razones recomendamos que el color de las hojas nuevas no se utilice como carácter diagnostico en la taxonomía de las cicadas.

INTRODUCTION

Cycads are highly appreciated as ornamental plants due to their ease of culture, long life span, and distinctive appearance. They reproduce by means of pollen and seed cones that are always produced on separate plants (i.e. they are dioecious), and can be quite distinctive in some species. The seed cones in particular are one of the

most appreciated ornamental characteristics of cycads. They can be quite large in some species, as exemplified by *Lepidozamia peroffskyana* Regel (Fig. 1A), that has cones reaching 1 m in length and 40 kg in weight (Norstog & Nicholls 1997:235) and are considered the largest cones in the plant kingdom. In addition to attaining impressive dimensions in some species, seed cones can often be quite colorful, particularly in the African genus *Encephalartos* as exemplified by the bright orange cones of *E. ferox* G. Bertol (Fig. 1B).

In addition to being appreciated for their highly ornamental strobili, cycads are also highly prized for their foliage. Cycads have distinctive pinnately compound leaves which are held in a rigid crown. Although cycad leaves are relatively conservative in their morphology compared to some other plant groups (Norstog & Nicholls 1997:49), they can be quite variable in terms of texture, leaflet arrangement, and the color of new leaf flushes. This variation in foliage is best exemplified by the neotropical genus *Zamia*, which is considered to be the most morphologically diverse genus in the order Cycadales.

Zamia, consisting of 75 accepted species (http://cycadlist.org), is the most species-rich cycad genus in the New World and has the broadest geographic distribution, ranging from Southern Georgia to Bolivia. Throughout its vast geographic range, the genus occupies a variety of diverse environments ranging from open, desert-like environments, to dense rainforests in some of the rainiest places on earth. Adaptation to these different environments has resulted in remarkable variation in leaf form within the genus.

Most species of *Zamia* may hold multiple leaves per crown, but some species, such as *Z. meermanii* Calonje, typically hold only 1–3 leaves per crown. Leaflets in *Zamia* vary in texture from soft and paper-like as in *Z. vazquezii* D.W. Stev., Sabato & De Luca (Fig. 2A), to rigid and cardboard-like, as in *Z. encephalartoides* D.W. Stev. (Fig. 2B), a desert-dwelling species from Colombia. Some species, such as *Z. hamannii* A.S. Taylor, J.L. Haynes & Holzman (Fig. 2C), have broad, deeply-veined leaflets.

Leaflets vary in size from the diminutive leaflets of *Z. pygmaea* Sims, which may represent the smallest leaflets in the cycadales (Fig. 2D), to the large paddle-like leaflets of *Z. imperialis* A.S. Taylor, J.L. Haynes & Holzman which at up to 75 cm in length and 21 cm in width (Taylor et al. 2008) may be the largest leaflets found in living cycads (Fig. 2E). Leaflets also vary in arrangement from being widely spaced along the rachis, such as those of *Z. imperialis*, to closely spaced and overlapping, such as in *Z. chigua* Seem. (Fig. 2F).

In addition to the remarkable diversity in leaflet shape, size, texture and arrangement, the genus *Zamia* exhibits the greatest diversity in the color of new vegetative flushes. The color of these young developing leaves is perhaps one of the most ornamentally appreciated features of the genus. New leaves are produced in an array of different colors, including bright orange (*Z. pyrophylla* Calonje, D.W. Stev., & A.Lindstr.; Fig. 3A), light green (*Z. nesophila* A.S. Taylor, J.L. Haynes & Holzman; Fig. 3B), reddish brown (*Z. lacandona* Schutzman & Vovides; Fig. 3C), white (*Z. stevensonii* A.S. Taylor & Holzman; Fig. 3D), reddish-orange (*Z. hamannii*; Fig. 3E), and reddish-brown (*Z. purpurea* Vovides, J.D. Rees & Vázq. Torres; Fig. 3F).

Flush color appears to be a fixed trait in many *Zamia* species and is sometimes used as a diagnostic taxonomic character. For example, *Z. hamannii* is distinguished from closely related species by its reddish-orange to rosy-pink flushes (Fig 3E; Taylor et al. 2008), whereas *Z. stevensonii* (Fig. 3D) is distinguished from its putative sister species *Z. elegantissima* Schutzman, Vovides & R.S. Adams by its white flushes compared to the bright yellow flushes of *Z. elegantissima* (Taylor & Holzman 2012).

Although flush color appears to be fixed in many species, it can also be variable in some species. For example, a wide array of colors has been observed in cultivated individuals of some species such as *Z. standleyi* Schutzman and *Z. vazquezii* (Broome 2002). As the exact provenance and pedigree of ornamentally cultivated cycads is often unknown, it is unclear whether the variation observed in some cultivated species is the result of source germplasm derived from separate populations with distinct flush colors, or if this variation can be found within individual wild populations.

Little has been published regarding the variability of flush color in wild populations of *Zamia* other than Schutzman's (1984) report of separate populations of *Z. splendens* Schutzman (currently considered synonym of *Z. katzeriana* (Regel) E. Rettig, sensu Nicolalde-Morejón et al. 2009) which produce either brilliant red or light green leaf flushes. However, the extent to which flush color may vary among and within populations of *Zamia* or even among the progeny of a single mother plant has not been previously examined.

Fig. 1. **A.** Mature cone of *Lepidozamia peroffskyana* held by Dr. Andrew Vovides. **B.** Seed cone of *Encephalartos ferox*.

Fig. 2. Leaf variability in *Zamia*. Leaves of: **A)** *Z. vazquezii*, **B)** *Z. encephalartoides*, **C)** *Z. hamannii*, **D)** *Z. pygmaea*, **E)** *Z. imperialis*, and **F)** *Z. chigua*.

Fig. 3. Variability of flush color in *Zamia*. **A)** *Z. pyrophylla*, **B)** *Z. nesophila*, **C)** *Z. lacandona*, **D)** *Z. stevensonii*, **E)** *Z. imperialis*, **F)** *Z. purpurea*, **G)** *Z. amplifolia*, **H)** *Z. integrifolia* from New Providence, Bahamas displaying variable flush color in two plants derived from same mother plant.

Since flush color is often used as a diagnostic character, understanding flush color variability could have taxonomic implications. Similarly, understanding the variability in flush colors may inform future selective breeding of desirable flush colors for ornamental horticulture.

In this paper we explore variability of flush color by examining a taxonomically and geographically comprehensive ex-situ conservation collection of Bahamian *Zamia* plants cultivated at Montgomery Botanical Center (Coral Gables, Florida, USA). This collection was developed from 2009–2011 as part of a conservation genetics project focused on *Zamia lucayana* (see Calonje et al. 2013).

MATERIALS AND METHODS

Seeds were collected from wild populations to establish ex-situ conservation collections at Montgomery Botanical Center (MBC) and The Retreat of Bahamas National Trust (Nassau, New Providence, The Bahamas). Sampling encompassed the entire known distribution range for the genus in The Bahamas, including multiple populations on six different islands (Abaco, Andros, Eleuthera, Grand Bahama, New Providence, and Long Island) and representing three different species according to current species delimitations (Osborne et al. 2012). The three sampled species were: *Zamia angustifolia* from Eleuthera, *Z. lucayana* from Long Island, and *Zamia integrifolia*, which as currently circumscribed has a wide distribution including Abaco, Andros, Eleuthera, Grand Bahama, and New Providence (Fig. 4). *Zamia angustifolia* is distinguished by having very narrow leaflets, whereas *Z. lucayana* has the broadest leaflets. *Zamia integrifolia* has leaflets that vary in width on different islands; populations from Andros, New Providence and Eleuthera have narrower leaflets and populations from Grand Bahama and Abaco have broader leaflets (Fig. 5).

Sampling of seeds followed protocols developed at Montgomery Botanical Center that aim to maximize the genetic diversity of the ex-situ collections by sampling seeds from up to five mother plants per population (see Walters 2003). Seeds derived from individual mother plants, representing half siblings, are kept separate and provided their own accession number.

Seeds were germinated and seedlings cultivated at MBC. Flush color was documented on plants with new leaves during the period of 2012–2013. New vegetative flushes were observed on a total of 1133 seedlings comprising 62 separate accessions derived from a total of 14 wild populations.

The distribution of flush color in the seedlings was analyzed using JMP 10.0.2 statistical software (SAS Institute, Inc, Cary, North Carolina, USA). Contingency table analysis was used to detect variation in leaf color distribution across islands and across species. Following significant contingency table homogeneity tests, binomial analyses were used for detailed comparisons among species, populations, accessions, and islands.

.

RESULTS

Flush color by species and island

At the species level, flush color was exclusively brown in *Z. angustifolia* (from 2 populations in Eleuthera), exclusively green in *Z. lucayana* (from 3 populations in Long Island), and variable in *Z. integrifolia,* where exclusively green flushes occur on Abaco, Grand Bahama, and Eleuthera, and both colors occur on Andros and New Providence (Fig. 3). It should be noted that species delimitation in Caribbean *Zamia* is particularly unclear, and species determinations are tentative pending ongoing genetic studies of Caribbean *Zamia* (e.g., Calonje et al. 2013; Salas-Leiva et al. 2013; Meerow et al. 2012) that seek to clarify the genetic relationships among these populations and shed some light on their taxonomy and nomenclature.

Green leaf flushes were observed on seedlings from all six islands, whereas brown flushes were limited to seedlings from New Providence, Andros, and northern Eleuthera (Figs. 6–8). The three islands where brown flushes occur are adjacent to each other and were part of a single landmass known as Paleoprovidence in the Pleistocene when sea levels were lower. Along these three islands, there appears to be a longitudinal gradient in flush color proportion, as seedlings of *Z. angustifolia* from northern Eleuthera were entirely brown emergent (100% brown), those from New Providence mostly brown (85% brown), and those from Andros mostly green (33% brown). Contingency table analysis showed significant variation among islands ($p < 0.0001$) and species ($p < 0.0001$) (Tables 1, 2).

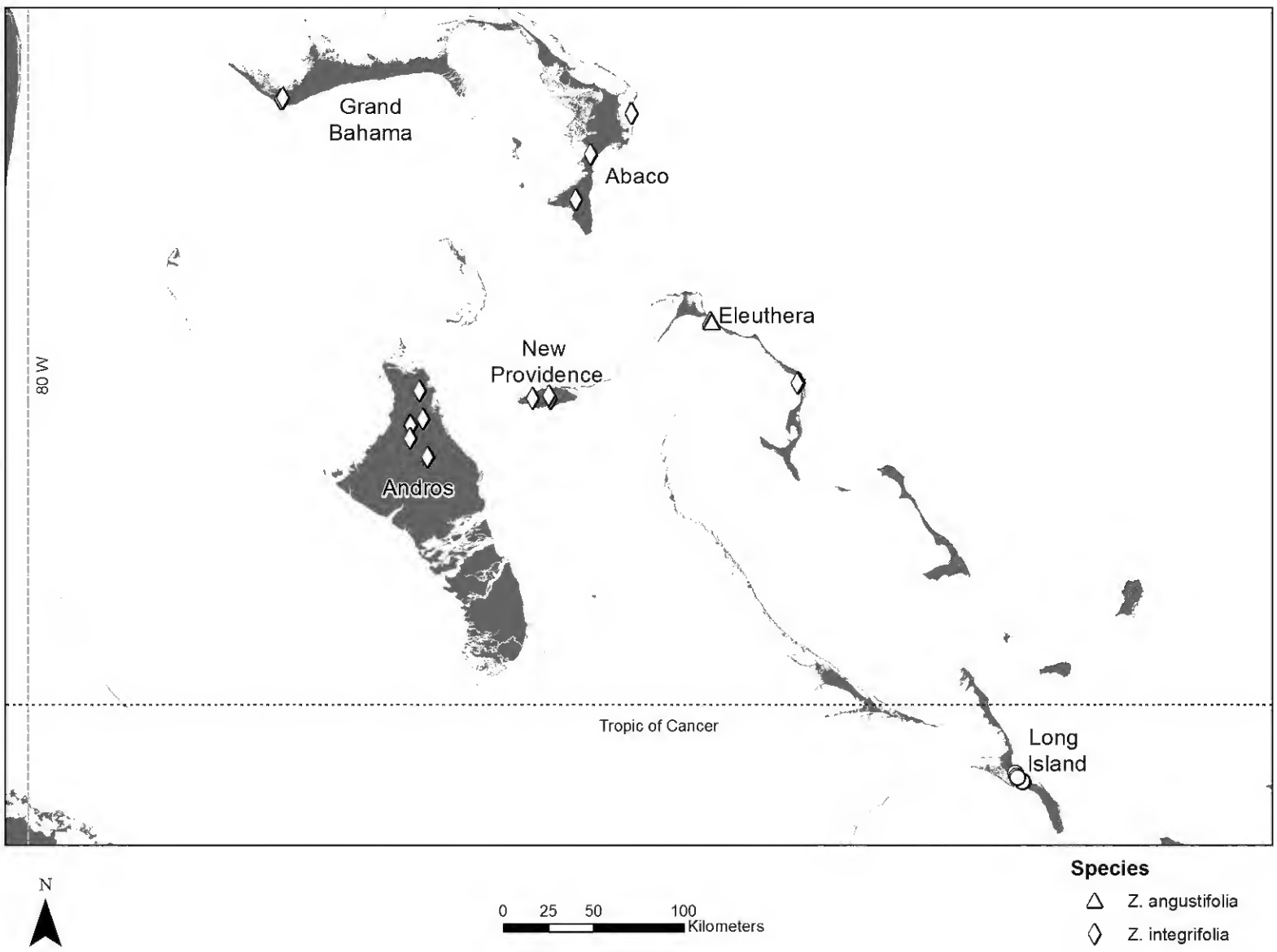


Fig. 4. *Zamia* collection sites in The Bahamas.

Flush Color by Population

Of the three Bahamian species, only *Z. integrifolia* exhibited variation in flush color, and only on the islands of Andros and New Providence (Figs. 6–7), where variation was found among populations, within populations, and within progeny of individual mother plants which were treated as separate accessions (Fig. 7). On Andros, observed *Zamia* populations were restricted to North Andros, and only the southernmost sampled populations yielded offspring with brown-emergent leaves (Fig. 7). In New Providence, only a small number of accessions yielded offspring with green flushes. Contingency table analysis showed significant variation among populations ($p < 0.0001$) (Table 3 for detailed comparisons).

DISCUSSION

Flush color in Bahamian *Zamia* species appears to be genetically determined, as variation in flush color was found within wild populations on Andros and New Providence, and within the progeny of individual mother plants cultivated under identical conditions in MBC's ex-situ conservation collection. Plants with different flush colors from both islands were otherwise consistent in vegetative morphology.

Cycads are diploid, meaning that they have two sets of homologous chromosomes which may carry two different forms of a particular gene (alleles) at the same location. We have observed only green and brown leaf flushes on Bahamian *Zamia*, indicating that there may be at least two different alleles in a single gene for flush color present in Bahamian *Zamia* populations. The variability observed suggests that the alleles for particular flush colors may be fixed in some species, populations, and half-sibling cohorts, but polymorphic in others.

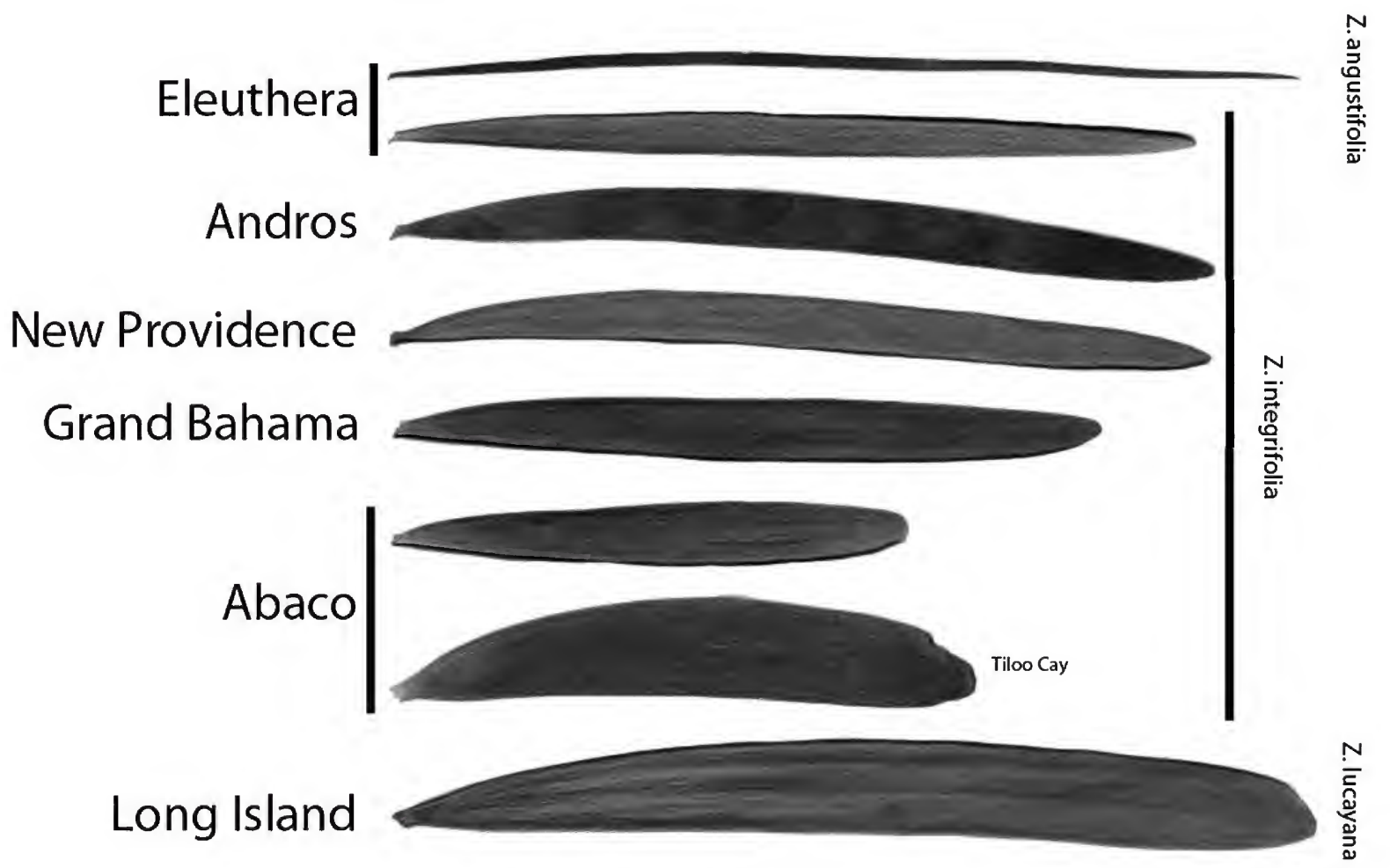


FIG. 5. Characteristic leaflet shapes of Bahamian *Zamia* populations.

TABLE 1. Numbers of brown and green emergent plants on different islands in the Bahamas.

Island	# Brown emergent	# Green emergent	Lower 95% CL* for % Brown emergent	Upper 95% CL* for % Brown emergent
Abaco	0	280	0.00%	1.31%
Long Island	0	192	0.00%	1.90%
Eleuthera	0	158	0.00%	2.31%
Grand Bahama	0	138	0.00%	2.64%
Andros Island	49	224	13.58%	23.03%
New Providence	124	23	77.45%	89.82%
Eleuthera	176	0	97.93%	100.00%

* CL = Confidence Limit

TABLE 2. Numbers of brown and green emergent plants for different *Zamia* species in the Bahamas.

Species	# Brown emergent	# Green emergent	Lower 95% CL* for % Brown emergent	Upper 95% CL* for % Brown emergent
Zamia lucayana	0	192	0.00%	1.90%
Zamia integrifolia	173	823	15.07%	19.87%
Zamia angustifolia	176	0	97.93%	100.00%

* CL = Confidence Limit

The differences in allele frequency among *Zamia* populations are likely the result of a combination of evolutionary forces including natural selection, genetic drift (particularly in small populations), and gene flow between populations (migration).

Assuming this trait is controlled by a single gene, it is not known whether a particular allele for flush color

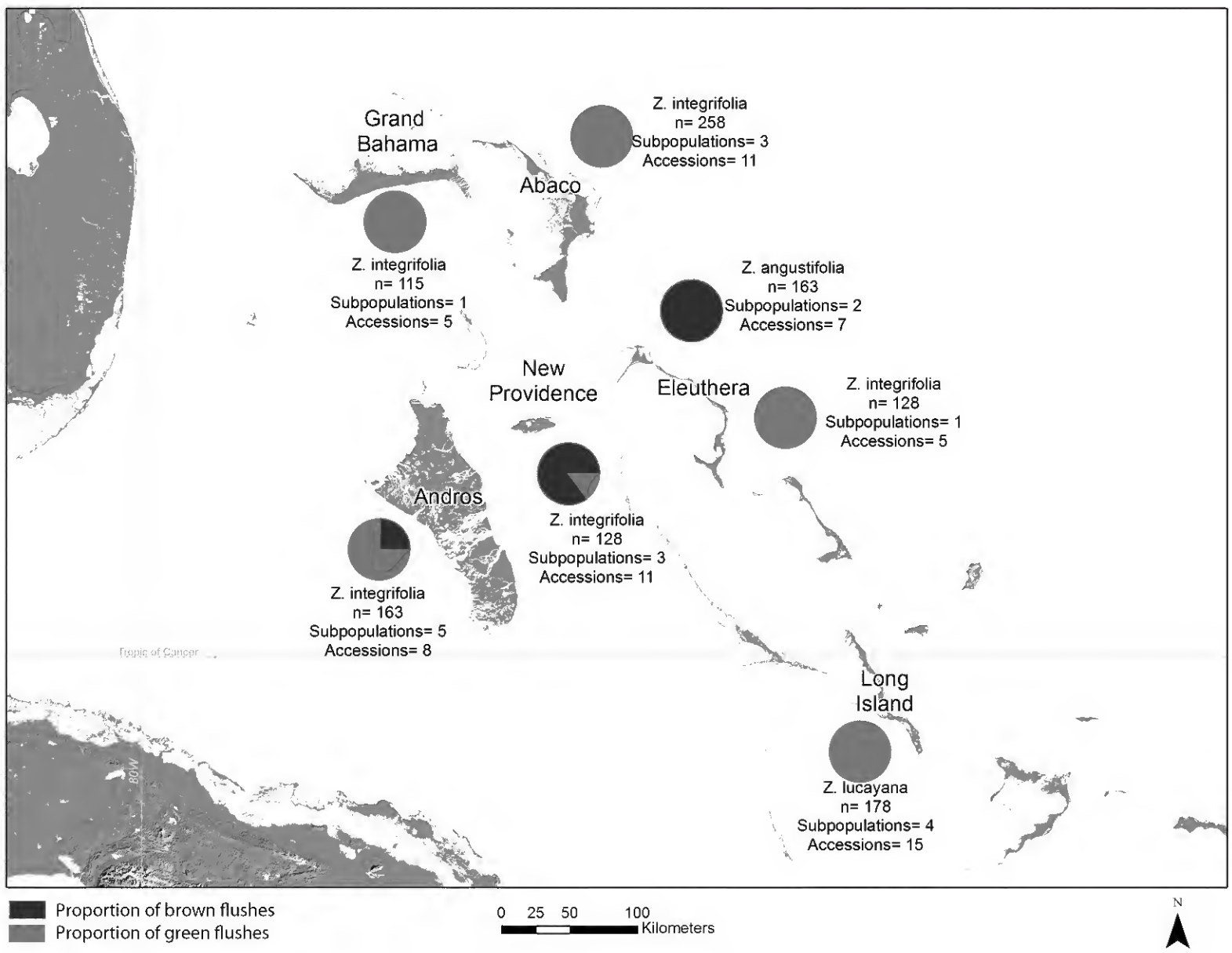


Fig. 6. Flush color distribution by species and island. Every island is represented by a single species except Eleuthera, which has separate populations of *Z. angustifolia* and *Z. integrifolia* with distinct flush colors.

may be dominant over the other, or whether this dominance may be consistent among different taxa. As the ex-situ collection at MBC is now beginning to reach reproductive maturity, the inheritance patterns of flush color may be determined by conducting controlled crosses between different plants and analyzing the flush color proportions of the resulting progeny. Caribbean species of *Zamia* are ideal for experimental crossing, because they can reach reproductive maturity in two to three years, which is relatively fast compared to other cycad species which may need a decade or longer to reach reproductive maturity.

It is not clear whether the brown flush color offers a selective advantage to cycads, but there are several possible hypotheses suggesting an advantage to brown or reddish flushes. The brown tint is believed to be produced by anthocyanins which may have fungicidal properties, protect leaves against UV damage, or make them inconspicuous to herbivores (Queenborough et al. 2013).

CONCLUSIONS

Flush color in Bahamian zamias varies geographically as well as at the species, population, and progeny levels, with color appearing to be fixed in some populations and variable in others. This variability suggests that to determine whether flush color is a fixed and therefore a diagnostic character for a given species, one would have to record flush color data from multiple individuals in each population and sample multiple populations. This is challenging data to collect because leaf production is seasonal and may not be synchronized among populations of a single species or individual plants within a population. Furthermore, a proportion of the population may not produce any leaves during a particular growing season, so collecting enough data to determine this would require long term study. Even if a fixed flush color were observed for a large sample of wild plants, at

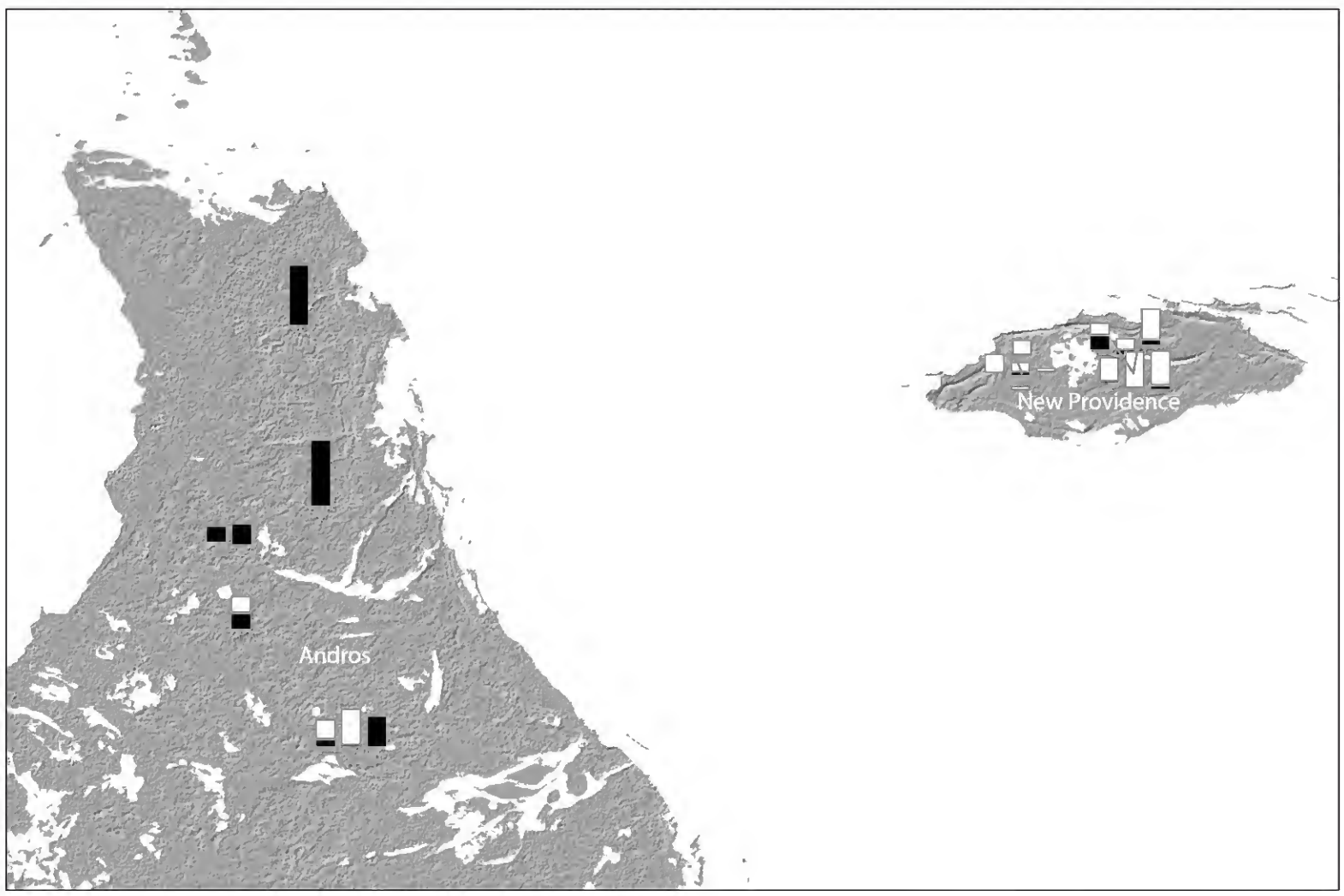


Fig. 7. Flush color of *Z. integrifolia* by accession in northern Andros and New Providence. Each bar represents a sampled accession, the height of the bar depending on the number of seedlings sampled from each accession, and the colors representing the proportion of flush colors found in the seedlings sampled from each accession.

Table 3. Numbers of brown and green emergent plants for different *Zamia* populations in the Bahamas.

Species	Population	# Brown emergent	# Green emergent	Lower 95% CL* for % Brown emergent	Upper 95% CL* for % Brown emergent
Zamia lucayana	13	0	192	0.00%	1.90%
Zamia integrifolia (Eleuthera)	6	0	158	0.00%	2.31%
Zamia integrifolia (Grand Bahama)	1	0	138	0.00%	2.64%
Zamia integrifolia (Abaco)	2	0	130	0.00%	2.80%
Zamia integrifolia (Abaco)	3	0	90	0.00%	4.02%
Zamia integrifolia (Abaco)	4	0	60	0.00%	5.96%
Zamia integrifolia (Andros Island)	10	0	58	0.00%	6.16%
Zamia integrifolia (Andros Island)	7	0	34	0.00%	10.28%
Zamia integrifolia (Andros Island)	11	9	9	26.02%	73.98%
Zamia integrifolia (Andros Island)	12	31	22	44.13%	71.86%
Zamia integrifolia (New Providence)	8	97	21	74.09%	88.63%
Zamia integrifolia (New Providence)	9	27	2	77.23%	99.15%
Zamia angustifolia	5	176	0	97.93%	100.00%

* CL = Confidence Limit

present it would be difficult to use this character state diagnostically in the absence of similar data available for other species.

Although a large number of leaf flushes were observed in this study, the flush color proportions reported for a given wild population are based on the progeny of a relatively small number of sampled mother plants,

and are not necessarily representative of the populations as a whole. Consequently, we believe that flush color information should be included in cycad species descriptions but should not be used as a diagnostic character for taxonomy.

Flush color is variable in some species and appears to be genetically determined. Future studies to determine the heritability of this characteristic would be useful to inform selective breeding of cycads to emphasize desirable flush colors for ornamental horticulture.

ACKNOWLEDGMENTS

Field work in The Bahamas was conducted in close collaboration with The Bahamas National Trust, USDA (Subtropical Horticulture Research Station, Miami), and Fairchild Tropical Botanic Garden, and was supported by The Mohamed bin Zayed Species Conservation Fund (project number 0925331) and matching funds from the Montgomery Botanical Center.

Some of the photographs were kindly provided by Greg Holzman (Figs. 3D–3F) and Bart Schutzman (Fig. 1A). David Knowles, Camilla Adair, Russell Adams, Sarah Gilmer, Louis Johnson, Javier Francisco-Ortega, Alan Meerow, and Claudia Calonje participated in the field work resulting in the ex-situ collections studied here. Javier Francisco-Ortega, Patrick Griffith, and Andrew Vovides reviewed an earlier version of the manuscript.

REFERENCES

Broome, T. 2002. A celebration of red and brown emergent cycads. Cycad Newslett. 25:4–7.

Calonje, M., A.W. Meerow, L. Knowles, D. Knowles, M.P. Griffith, K. Nakamura, & J. Francisco-Ortega. 2013. Cycad biodiversity in the Bahamas Archipelago and conservation genetics of the threatened *Zamia lucayana* (Zamiaceae). Oryx 47:190–198.

Cycadlist.org. The world list of cycads. Accessed 03 Feb 2014. http://cycadlist.org

Meerow, A.W., J. Francisco-Ortega, M. Calonje, M.P. Griffith, T. Ayala-Silva, D.W. Stevenson, & K. Nakamura. 2012. *Zamia* (Cycadales: Zamiaceae) on Puerto Rico: Asymmetric genetic differentiation and the hypothesis of multiple introductions. Amer. J. Bot. 99:1828–1839.

Nicolalde-Morejón, F., A.P. Vovides, & D.W. Stevenson. 2009. Taxonomic revision of *Zamia* in Mega-Mexico. Brittonia 61:301–335.

Norstog, K.J. & T.J. Nichols. 1997. The biology of the cycads. Cornell University Press, Ithaca, New York, U.S.A.

Osborne, R., M. Calonje, K.D. Hill, L. Stanberg, & D.W. Stevenson. 2012. The world list of cycads. Mem. New York Bot. Gard. 106:480–510.

Queenborough, S.A., M.R. Metz, R. Valencia, & S.J. Wright. 2013. Demographic consequences of chromatic leaf defence in tropical tree communities: Do red young leaves increase growth and survival? Ann. Bot. 112:677–684.

Salas-Leiva, D.E., A.W. Meerow, M. Calonje, M.P. Griffith, J. Francisco-Ortega, K. Nakamura, D.W. Stevenson, C.E. Lewis, & S. Namoff. 2013. Phylogeny of the cycads based on multiple single-copy nuclear genes: Congruence of concatenated parsimony, likelihood and species tree inference methods. Ann. Bot. 112:1263–1278.

Schutzman, B. 1984. A new species of *Zamia* L. (Zamiaceae, Cycadales) from Chiapas, Mexico. Phytologia 55:299–303.

Taylor, A.S., J.L. Haynes, & G. Holzman. 2008. Taxonomical, nomenclatural and biogeographical revelations in the *Zamia skinneri* complex of Central America (Cycadales: Zamiaceae). Bot. J. Linn. Soc. 158:399–429.

Taylor, A.S. & G. Holzman. 2012. A new *Zamia* species from the Panama Canal Area. Bot. Rev. 78:335–344.

Walters, T. 2003. Off-site collections. In: J. Donaldson, ed. Cycads: Status survey and conservation action plan. IUCN, Gland, Switzerland and Cambridge, UK. Pp. 48–53.

LIMITATIONS TO NATURAL PRODUCTION OF *LOPHOPHORA WILLIAMSII* (CACTACEAE) III. EFFECTS OF REPEATED HARVESTING AT TWO-YEAR INTERVALS FOR SIX YEARS IN A SOUTH TEXAS (U.S.A.) POPULATION

Martin Terry

Sul Ross State University
Department of Biology
Alpine, Texas 79832, U.S.A.

Keeper Trout

Cactus Conservation Institute
P.O. Box 561
Alpine, Texas 79831, U.S.A.

Bennie Williams

Cactus Conservation Institute
P.O. Box 561
Alpine, Texas 79831, U.S.A.

Teodoso Herrera

Rio Grande Native American Church
P.O. Box 460346
San Antonio, Texas 78246, U.S.A.

Norma Fowler

The University of Texas at Austin
Department of Integrative Biology C0930
205 W 24th St
Austin, Texas 78712, U.S.A.

ABSTRACT

Here we report the 6-year results of a long-term study of the effects of harvesting on a wild population of the cactus *Lophophora williamsii* (peyote). Harvesting was performed using the best known technique: removing only the crown from the top of the plant. The two-year interval between harvests was chosen because it was similar to that observed by persons who harvest peyote for legally protected religious use by members of the Native American Church. Plants in the study were divided into three treatment groups: (1) control plants that were never harvested, (2) plants that were harvested only once, at the beginning of the study, and (3) plants that were harvested at the beginning of the study and every two years thereafter. Over the last two years of the study (2012–2014), the survival rate was significantly lower (77%) in the plants harvested every two years than in the once-harvested plants (100%) and the unharvested control plants (98%). At the end of the 6th year of the study, average volume of living crown tissue per plant was significantly and substantially lower in the plants harvested every two years than in the once-harvested plants and the unharvested controls. The average volume of once-harvested plants was 27% lower than that of the controls, although this latter difference was not statistically significant. The modal number of crowns per plant varied with treatment and over time; in the plants harvested every two years it underwent a progression from 1 to 2 to 3 to 1 in response to successive harvests. The results of this study indicate that a six-year recovery period, following the harvesting of peyote in natural habitats, is probably not long enough to ensure long-term sustainability.

Key Words: cactus conservation, peyote harvest, cactus overharvesting, Native American Church, peyote conservation status

RESUMEN

Aquí reportamos los resultados de seis años de un estudio a largo plazo sobre los efectos de cosechar individuos del cactus *Lophophora williamsii* (peyote) en una población silvestre. La cosecha se hizo utilizando la mejor técnica que se conoce, recogiendo solamente la corona de la parte superior de la planta. El intervalo de dos años entre cosechas fue similar al utilizado por personas que cosechan peyote para uso jurídicamente protegido por los miembros de la Native American Church. Las plantas en el estudio fueron divididas en tres grupos de tratamiento: (1) las plantas de control que nunca fueron cosechadas, (2) las plantas que fueron cosechadas sólo una vez, al comienzo del estudio, y (3) las plantas que fueron cosechadas al comienzo del estudio y posteriormente cada dos años. En los últimos dos años del estudio (2012–2014), la tasa de supervivencia fue significativamente menor (76,5%) en las plantas cosechadas cada dos años, que en las plantas cosechadas una sola vez (100%) y las plantas de control que no fueron cosechadas nunca (97,7%). Al final del sexto año del estudio, el volumen promedio del tejido vivo de la corona por planta fue significativamente menor en las plantas cosechadas cada dos años, que en las plantas cosechadas una sola vez y las plantas de control que nunca fueron cosechadas. El número modal de coronas por planta varió con el tratamiento y con el tiempo; en las plantas cosechadas cada dos años hubo una progresión desde 1 a 2 a 3 a 1 en respuesta a las cosechas sucesivas. Los resultados de este estudio indican que un período de recuperación de seis años después de la recolección del peyote en el hábitat probablemente no es suficientemente largo como para asegurar la sostenibilidad a largo plazo.

INTRODUCTION

Lophophora williamsii (Lem. ex Salm-Dyck) J.M. Coult. (Cactaceae), commonly known as peyote, is a small globular cactus of northeastern Mexico and adjacent border areas of Texas. The crowns (apical chlorophyllous portions of the stem) of these plants are approximately hemispherical in shape and generally protrude a few cm above ground level. Some plants are caespitose, i.e., they have multiple crowns arising from a single nonchlorophyllous (generally subterranean) stem. What was known of the biology of this species up to the mid-1990s is summarized by Anderson (1996). Early suggestions that the species might be threatened by overharvesting came from Morgan (1976), Anderson (1995), and Trout (1997).

The harvested crowns of peyote are collected and sold by licensed distributors to the Native American Church (NAC) for religious use as protected by U.S. law. The anatomy of harvesting and the process of regeneration of new crowns in response to harvesting are described by Terry and Mauseth (2006). It is now abundantly clear that the current rate of harvesting of peyote from wild populations is not sustainable (IUCN 2013; NatureServe 2012; Terry et al. 2011, 2012). In March 2008 we began the first experimental investigation of the effects of harvesting on peyote plants in situ. In previous papers we reported the effects that were detectable two years (Terry et al. 2011) and four years (Terry et al. 2012) after the initial harvest. The present report focuses on effects detectable six years after the initial harvest, in once-harvested plants and/or in plants harvested every two years, the latter treatment representing the harvest frequency observed by persons who harvest peyote for legally protected religious use by members of the Native American Church.

MATERIALS AND METHODS

The study site in the Tamaulipan thornscrub of South Texas was described previously by Terry et al. (2011). The study design was described in detail by Terry et al. (2012). In summary, there were three treatment groups: (1) a group of 50 plants which were unharvested control plants; (2) a group of 25 plants which were harvested only once, at the beginning of the study; (3) a group of 25 plants which were harvested at the beginning of the study and reharvested every two years thereafter. All plants were harvested using the best known technique, removing only the crown from the top of the plant with a sharp knife. All plants in the study were individually numbered and tagged in situ, along a transect through the population. Data collected on each plant at each census (0, 2, 4 and 6 years) included number of crowns, number of ribs on each crown, and diameters of the crowns. All statistical analyses were done with SAS 9.3 (SAS Institute, Cary, NC, USA).

Statistical analyses of survival.—Because a census of plants was conducted every two years (2008, 2010, 2012, 2014), each census interval was two years long. Harvesting was done directly after each census, and therefore survival rates reflect the effects of treatments of preceding years, but not of the treatment of the census year. Survival rates were calculated for each census interval separately. Only plants present at the beginning of the given interval (and not dug up by feral hogs during the interval) were used to calculate survival rates. Four plants were dug up by hogs during the first interval and were therefore dropped from all survival calculations, and one plant was dug up during the third interval and was therefore dropped from the calculation of survival rate during the third interval. Figure 1 is not an exact representation of cumulative survival rates (which would have been affected by hog-caused mortality), but instead shows the products of the calculated interval survival rates for each treatment (e.g., the proportion of plants surviving to census 3 is the product of the survival rate from census 1 to census 2, times the survival rate from census 2 to census 3).

A single survival rate was calculated for harvested plants for the first census interval (2008–2010), because both groups of harvested plants were harvested after the first census. The "plants harvested once" were not harvested again. Plants harvested once and plants harvested multiple times were separated in the analyses of survival during the second (2010–2012) and the third (2012–2014) census intervals. Fisher's exact test was used to compare treatments within each of the three census intervals, because the expected values of some cells were < 5, making ordinary χ^2 tests inappropriate.

Statistical analyses of size.—Our primary measure of plant size was estimated total above-ground volume. It

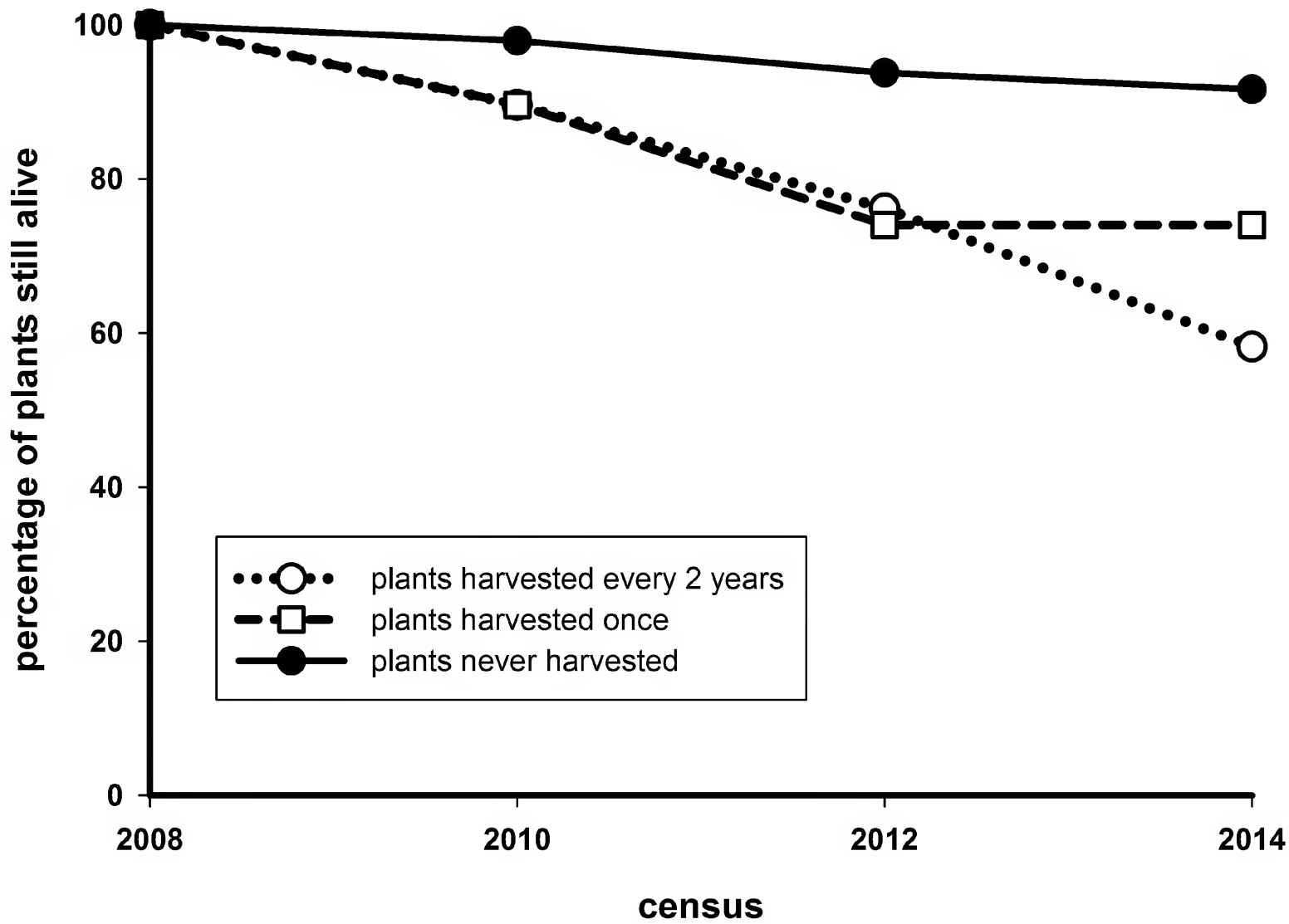


Fig. 1. Cumulative proportions of plants remaining alive after excluding plants dug up by hogs from the calculations (see Methods). Plants were harvested immediately after each census. Plants harvested once were harvested only after the first census (2008). For statistical tests, see Table 1.

was calculated from the diameter of each crown by assuming that each crown was a hemisphere: estimated crown volume = $\frac{2}{3}\pi$ (crown diameter/2)^3. If a plant had multiple crowns in a given census, the estimated volumes of all of its crowns were summed to obtain estimated total above-ground volume of that plant. As is usual with plant size measurements, the distribution of volume was skewed, with a right tail (i.e., a few large plants, more smaller plants). No single transformation of total volume produced residuals that met the assumptions of analysis of variance for all years. Instead, volumes from censuses in 2008 and 2012 were square-root transformed before analysis, and volumes from censuses in 2010 and 2014 were log-transformed before analysis. (The log-transformation over-corrected skewness in the censuses of 2008 and 2012; the square-root transformation under-corrected it in the censuses in 2010 and 2014). Treatments were then compared with analysis of variance (ANOVA). If the effect of treatment was significant and there were >2 treatments to be compared, individual treatments were compared, using the Tukey adjustment for multiple testing. For graphical presentation (Fig. 2), the mean, mean plus 1 standard error, and mean minus 1 standard error of each treatment were separately back-transformed with the appropriate function, using the standard error of each treatment from the corresponding ANOVA.

Another measure of size is the number of crowns per plant. When the experiment was initiated, each experimental plant included in the groups to be harvested had exactly one crown. That constraint was not imposed on the control plants, however, and the few multi-crowned individuals that occurred along the study transect were not rejected from inclusion in the control group. This was done in order to ensure that the control group was representative of the population in terms of the full range of crown numbers per individual plant. The number of crowns/plant in each subsequent census was found to be Poisson distributed, and treatments each year were therefore compared with a generalized linear model with a Poisson distribution for which the

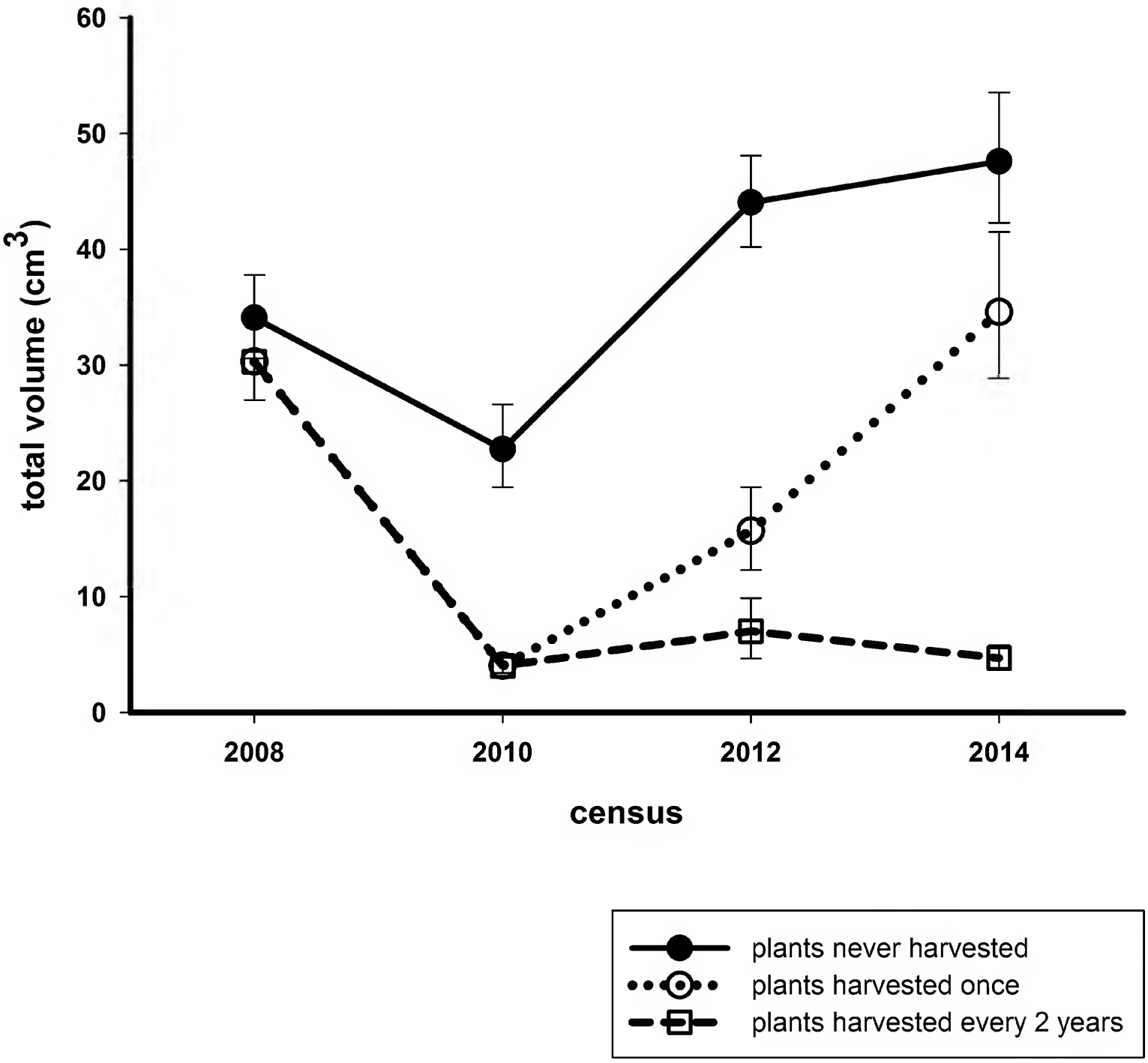


Fig. 2. Plant size, measured as total above-ground volume. Points represent back-transformed means; error bars are means ± 1 standard error, separately back-transformed.

log is the link function. To supplement this analysis, we also calculated the change in number of crowns of each surviving plant during each of the last two census intervals, and compared the distributions of size changes among treatments with Fisher's exact test.

RESULTS

Survival.—Survival rates of control plants remained high: more than 95% in each two-year census interval (Table 1, Fig. 1). Survival rates of plants harvested every two years were consistently lower than those of control plants, and decreased over time; the rate at which these plants survived the third census interval, by which time they had been harvested three times, was only 77%. There is evidence that the negative effect of harvesting on survival lasts more than two years: survival rates of once-harvested plants did not return to control levels until four years had passed after they were harvested (i.e., until the third census interval, 2012–2014).

Size.—The once-harvested plants appeared to continue to be in the process of recovering from the adverse effects of being harvested six years before (Table 2, Fig. 2). Six years after harvesting, we no longer were able to detect a significant difference in size (total above-ground volume) between never-harvested and once-harvested

TABLE 1. Survival rates during each census interval. Plants were harvested immediately after each census; plants harvested once were harvested only after the first census. NS, not significant.

	2008–2010	2010–2012	2012–2014
control plants	97.9%	95.7%	97.7%
plants harvested once	89.6%	82.6%	100%
plants harvested every two years	89.6%	85%	76.5%
	NS	$P = 0.013$	$P = 0.0097$
sample size	N = 96	N = 89	N = 80

TABLE 2. Results of ANOVAs comparing plant volumes among treatments. All harvests took place immediately after the census in the calendar year indicated. Analyses for census years 2008 and 2010 compare unharvested and harvested plants; the first harvest (2008) occurred after the first census. Analyses for census years 2012 and 2014 compare unharvested plants, plants harvested once (after the 2008 census), and plants harvested every two years (i.e., after the censuses of 2008, 2010, and 2012). Control, never harvested; once, harvested once after the first census; multi, harvested every two years after each census.

census year	transformation used	F	$P_{treatment}$	multiple comparisons		
				control v once	control v multi	once v multi
2008	square root	$F_{1,98} = 0.59$	NS	—[a]	—[a]	—[a]
2010	log	$F_{1,88} = 58.31$	< 0.0001	—[a]	—[a]	—[a]
2012	square root	$F_{2,76} = 28.73$	< 0.0001	<0.0001	<0.0001	0.13
2014	log	$F_{2,71} = 45.29$	< 0.0001	0.31	<0.0001	<0.0001

[a] no multiple comparisons needed; treatment P value compares control and harvested plants

plants. This of course does not mean that the once-harvested plants had completely recovered, especially given that small sample sizes reduced the power of our test. A power analysis of our results indicates that, given the average control plant size of 48 cm^3 in the 2014 census and the observed distribution of plant sizes in that census, we could have detected a significant difference between the control and the once-harvested plants only if the once-harvested plants had been < 28 cm^3 in size on average (42% smaller); in fact, they were 35 cm^3 in size on average (only 27% smaller). In contrast, the plants harvested every two years remained very small. We were not able to detect a temporal trend in the volume of those plants, perhaps because very small plants simply died.

As the experiment proceeded, the distribution of crown numbers in control (i.e., never harvested) plants remained quite constant (Figs. 3 and 4), with the average number of crowns per control plant remaining close to 1.7 (Table 3). The majority of control plants always had one crown, but note the long right tails of the distributions in Fig. 3, each of which includes a few control plants with five or more crowns each.

The first harvest (2008) caused a significant increase in the number of crowns per harvested plant, with a modal value of 2 crowns per plant and a mean of 2.58 (Table 3, Fig. 3). (However, these new crowns were quite small; recall that harvesting reduced average plant volume substantially). Over the next four years plants that were not re-harvested continued to have a modal value of 2 crowns per plant, with little change in their distribution (Figs. 3 and 4).

The second harvest of plants harvested every two years shifted the modal value to 3 crowns per plant (mean 2.56) in 2012, which was more crowns/plant than the once-harvested plants in the same census had (mode 2, mean 2.16 crowns/plant) (Table 3; Fig. 3, census 2012). However, 31% (5 of 16) of plants harvested every two years decreased in crown number during this period (Fig. 4, 2010–2012). The statistical test comparing crown number distributions among treatments in 2012 did not quite reach significance (Table 3: $P = 0.09$), nor did the statistical test comparing changes in crown number ($P = 0.18$).

The third harvest of plants harvested every two years reduced the average number of crowns per plant in 2014, and one crown per plant was once again the most common value in these plants (Fig. 3, census 2014,

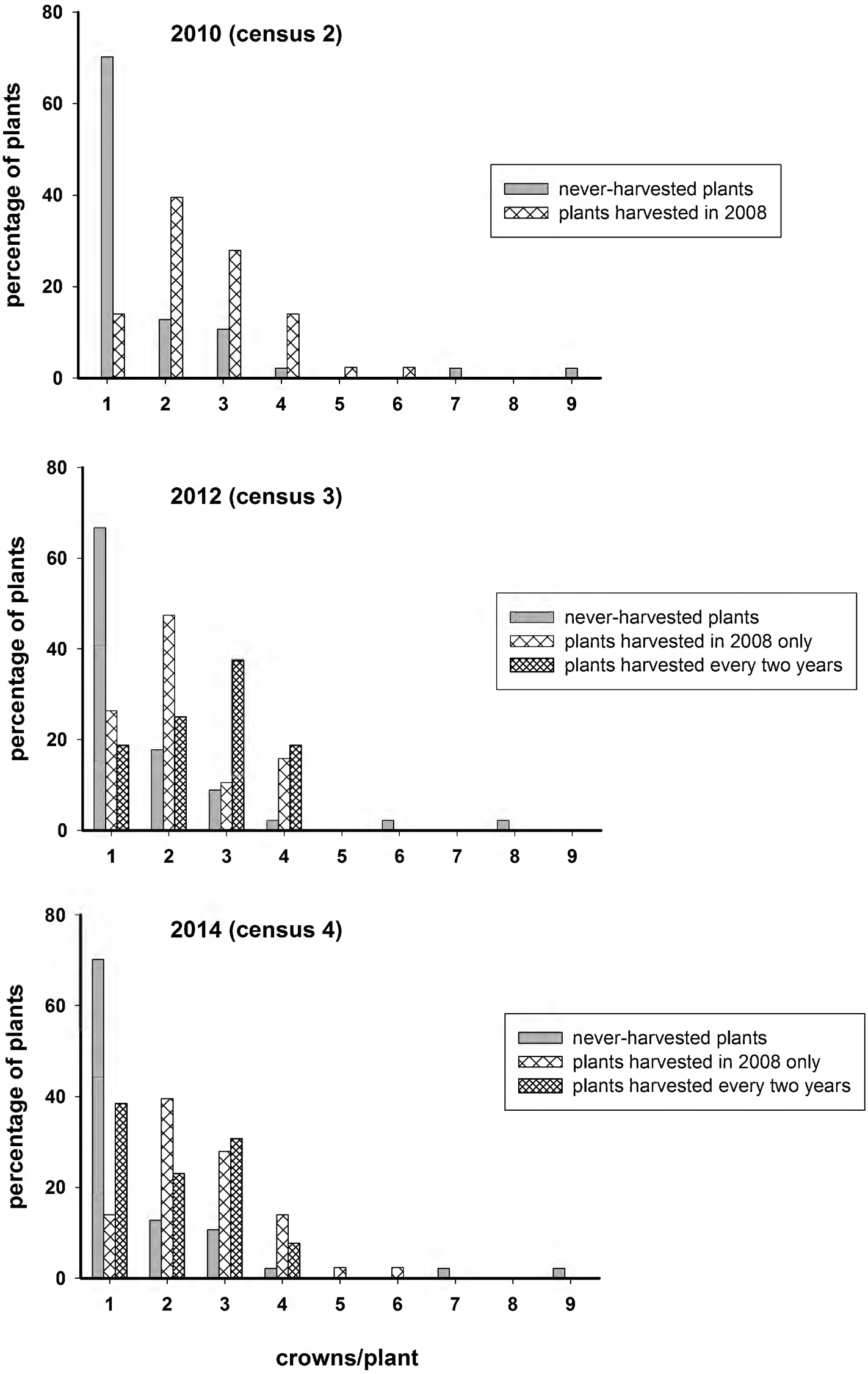


Fig. 3. Distributions of numbers of crowns per plant. For statistical tests, see Table 3.

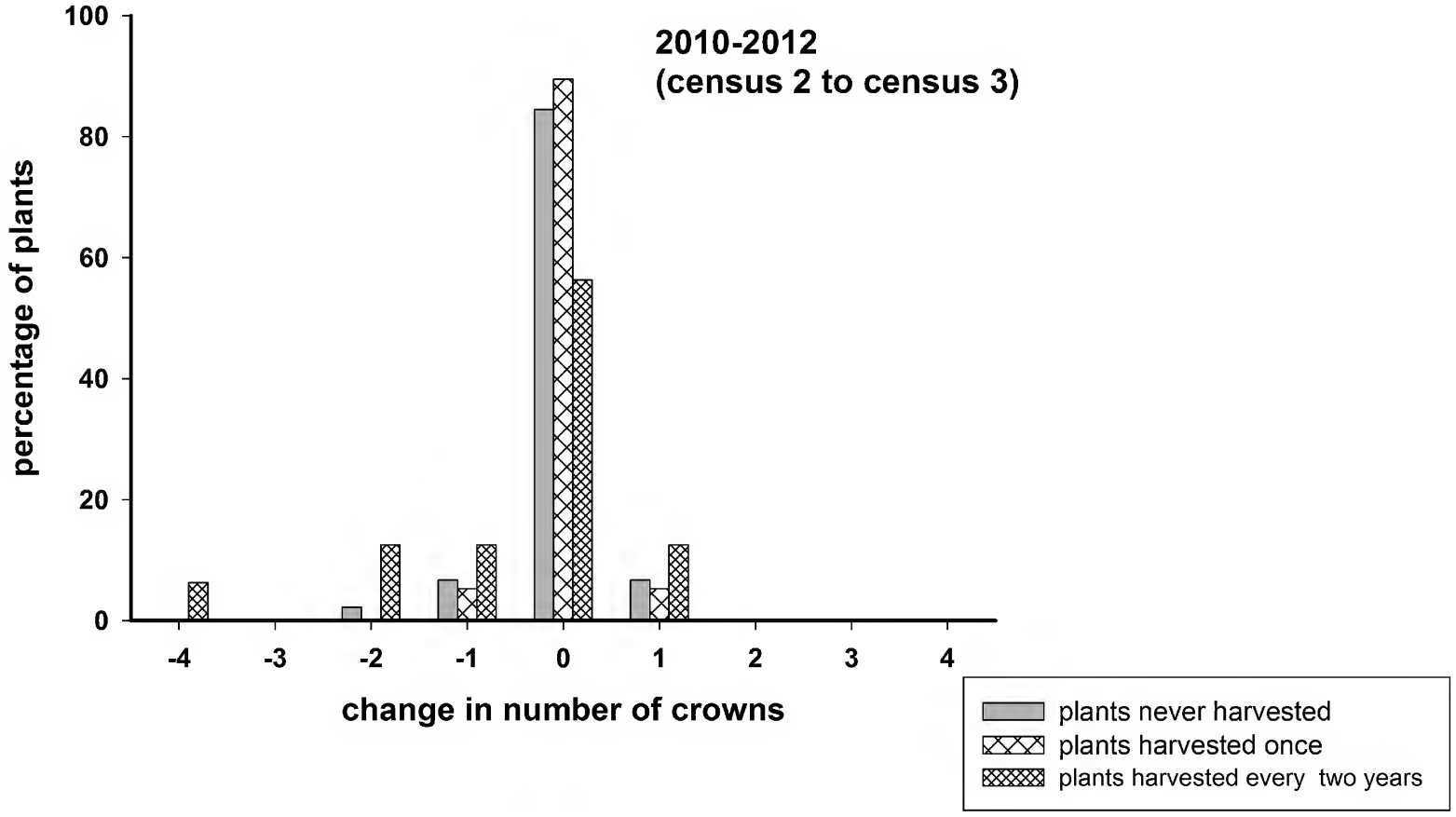


Fig. 4. Distributions of changes in the number of crowns per plant.

plants harvested every two years). Of plants harvested every two years, 58% (7 of 12) had fewer crowns at the end of this census interval (2014) than they did at its beginning (2012) (Fig. 4, 2012–2014, plants harvested every two years). While the differences in crown number among treatments did not reach statistical significance in 2014 (Table 2: $P = 0.31$), the statistical comparison of the changes in crown number (Fig. 4, 2012–2014) among treatments was highly significant ($P < 0.0001$).

DISCUSSION

During the fifth and sixth years of this ongoing experimental study of a peyote population, we saw few changes in the behavior of never-harvested (control) plants. Once-harvested plants continued to recover from harvesting, but plants harvested every two years continued to experience lowered survival rates and to be quite

Table 3. Numbers of crowns per plant.

	comparison of treatments		average no. of crowns/plant
	F (df)	P	
census year 2010	8.06 (1,88)	0.006	
control			1.70
harvested			2.58
census year 2012	2.46 (2,77)	0.09	
control			1.69
once-harvested			2.16
harvested every 2 yrs			2.56
census year 2014	1.19 (2,71)	0.31	
control			1.74
once-harvested			2.33
harvested every 2 yrs			2.08

small, but for the first time also showed a reduced capacity to produce new crowns. The survival rate and individual sizes of never-harvested plants indicate that the site continued to be suitable for this species. However, the loss of plants to digging, apparently by feral hogs, did not cease; it continued to be a concern.

Effects of harvesting.—The recovery of once-harvested plants from their harvest in 2008 appeared to be nearly complete in terms of survival: their survival from 2012 to 2014 was not different from that of the never-harvested plants. This delayed but marked increase in the survival rate of the once-harvested group attests to the resilience of the species when it is allowed a long enough respite from further harvesting. But note that this recovery was delayed and occurred only in the third two-year period after harvesting; harvesting reduced survival for at least four years.

By our best measure of size, the estimated above-ground volume of each plant, the once-harvested plants also continued to recover in terms of size (Fig. 2). However, inspection of Fig. 2 suggests that this recovery was not yet complete in 2014. Although the difference in size between never-harvested and once-harvested plants was no longer significant in 2014, this does not mean that the two groups did not differ. A power analysis of our data indicated that, due to plant-to-plant variability and small sample sizes, only differences of 42% or more from average control plant size would have been detected as statistically significant. In other words, the relatively low power of the analysis made a type II error (false negative, i.e., failure to reject the null hypothesis) very likely as soon as the once-harvested plants were about half the size of the never-harvested plants. If we had been able to design the study with a total of 500 plants instead of 100 (which would have implied finding a landowner who was willing to allow 250 peyote plants to be harvested from his property), we would have had substantially greater statistical power, which might well have resulted in a *P* value less than 0.05 for the comparison of control and once-harvested plants. The pattern evident in Fig. 2, these statistical considerations, and the precautionary principle, strongly support the assumption that **six years is not long enough to wait** after a population of peyote is harvested before going back and re-harvesting the population, if the goal is a sustainable regimen of harvesting.

In contrast to the ongoing recovery of once-harvested plants, the plants harvested every two years continued to die at significantly higher rates during 2012–2104, and the survivors remained extremely small. All evidence continues to support the conclusion that harvesting this species every two years, even using best-practice harvesting methods, is not sustainable.

Can the increase in crown number compensate for the negative effects of harvesting?—If the death of one crown on a plant is independent of the death of another crown on the same plant, then having more crowns would increase the plant's chance of survival. It is not clear what mechanisms would create this scenario, because both resource competition and herbivory likely affect all the crowns of a plant at once. However, it is possible that this scenario was in part the reason that the survival rate of once-harvested plants recovered from

harvesting before their volume did. In any case, the multiple crowns of the repeatedly-harvested plants did not prevent their survival rate from remaining lower than that of control plants.

By 2014 the number of crowns of the repeatedly-harvested plants had declined from its peak in 2012, while the above-ground volume of these plants remained extremely low. It seems likely that these repeatedly-harvested plants had exhausted most of their stored resources by 2014 and therefore their ability to regrow following harvest was reduced. Presumably each harvest used up stored carbohydrates and other resources, as well as reducing the length of time during which the plant could accumulate new resources via photosynthesis. Viable areoles on the nonchlorophyllous/subterranean portion of the stem are probably also depleted by repeated regrowth after harvesting. Such areoles are not replaced, as they are generated early in the life of the plant at the apical meristem and migrate radially as the plant grows, ultimately becoming incorporated into the basal (non-chlorophyllous) portion of the stem, below the crown. Once such an areole is used up in producing regrowth in the form of an axillary branch with its new crown, that areole is permanently extinguished by the harvesting of that crown.

Management implications.—The continuing decline of the plants harvested every two years clearly and strongly supports not harvesting wild-grown peyote plants this frequently. As we argued in a previous paper (Terry et al. 2012), frequent harvests are producing a classic case of the overharvesting of a wild population.

We also conclude that even six years is probably not long enough for plants to recover from harvesting, even using best-practice harvesting methods (clean knife cut, leaving the non-chlorophyllous stem and roots intact). It is possible that eight years between harvests would allow recovery; we do not have data to address this hypothesis as yet. However, for the purpose of considering conservation options, let us make the assumption that eight years would be sufficient for plants to completely recover from a single harvest of their crowns by the current best-practice method. We have heard several objections to the proposition that cultivation of peyote is the single most viable solution to the current problem of reduced availability of peyote. One of the most frequently heard objections is that "10 years is too long" to wait for peyote planted from seed to reach maturity in a greenhouse so that it would be available for harvesting for ceremonial use by the Native American Church. But if that 10-year waiting period for sustainable production of cultivated peyote is now compared to an 8-year waiting period required for sustainable production of peyote in its natural habitat, perhaps the 10-year wait for greenhouse cultivation to come on line to allow adequate annual production for the Church's ceremonial needs is not so unreasonable after all. A greenhouse-grown supply of peyote would also eliminate all the uncertainty of relying on collection from the wild and greatly reduce the real possibility that this species will soon become commercially extinct in the wild, that is, so rare that it is no longer economically feasible to collect wild plants.

ACKNOWLEDGMENTS

We thank C.W. Hellen Ranches, Ltd. – La Mota Division – Charles W. (Bill) Hellen, Managing Partner, for providing access to a site where a long-term study such as this can be carried out safely. Essential funding for the study was generously provided by the Alvin A. and Roberta T. Klein Foundation, Sul Ross State University (Research Enhancement grant and use of the SRSC herbarium), and all the donors supporting the scientific work of the Cactus Conservation Institute, Inc. We thank A. Michael Powell and Billie L. Turner for prompt and careful reviews.

REFERENCES

Anderson, E.F. 1995. The "Peyote Gardens" of South Texas: A conservation crisis? Cact. Succ. J. (U.S.) 67:67–73.

Anderson, E.F. 1996. Peyote: The divine cactus. University of Arizona Press, Tucson, U.S.A.

International Union for the Conservation of Nature (IUCN). 2013. IUCN Red List of threatened species. *Lophophora williamsii* assessment: Vulnerable. www.iucnredlist.org/details/151962/0 (Accessed: 6 December 2013.)

Morgan, G.R. 1976. Man, plant, and religion: Peyote trade on the Mustang Plains of Texas. Ph.D. Thesis, University of Colorado.

NatureServe. 2012. NatureServe Explorer: An online encyclopedia of life [web application]. Version 7.1. NatureServe, Arlington, Virginia. Available at http://www.natureserve.org/explorer (Accessed: July 3, 2012.)

Terry, M. & J.D. Mauseth. 2006. Root-shoot anatomy and post-harvest vegetative clonal development in *Lophophora williamsii* (Cactaceae: Cacteae): Iimplications for conservation. Sida 22:565–592.

Terry, M., K. Trout, B. Williams, T. Herrera, & N. Fowler. 2011. Limitations to natural production of *Lophophora williamsii* (Cactaceae) I. Regrowth and survivorship two years post harvest in a South Texas population. J. Bot. Res. Inst. Texas 5:661–675.

Terry, M., K. Trout, B. Williams, T. Herrera, & N. Fowler. 2012. Limitations to natural production of *Lophophora williamsii* (Cactaceae) II. Effects of repeated harvesting at two-year intervals in a South Texas population. J. Bot. Res. Inst. Texas 6:567–577.

Trout, K. 1997. Sacred cacti. Narayan Publications, Sedona, Arizona, U.S.A.

DISTIGOUANIA IRREGULARIS (RHAMNACEAE) GEN. ET SP. NOV. IN MID-TERTIARY AMBER FROM THE DOMINICAN REPUBLIC

Kenton L. Chambers

Department of Botany and Plant Pathology
Oregon State University
Corvallis, Oregon 97331, U.S.A.
chamberk@science.oregonstate.edu

George O. Poinar, Jr.

Department of Integrative Biology
Oregon State University
Corvallis, Oregon 97331, U.S.A.
poinarg@science.oregonstate.edu

ABSTRACT

Distigouania irregularis (Rhamnaceae) is described as a new genus and species of fossil angiosperm from deposits of Mid-Tertiary amber in the Dominican Republic, on the Caribbean island of Hispaniola. The fossil is represented by a single staminate flower at anthesis and displays an irregular corolla in which 4 petals are rhombic-lanceolate, spreading, and sepal-like, while the 5th is shorter, erect, and slightly cupped. The stamens are dimorphic; the 4 that are opposite the spreading petals have dehisced anthers on erect filaments that diverge from the petals, while the 5th stamen adjoins the erect, cupped petal and has a larger, unopened anther. The hypanthial disc is densely pubescent with tangled trichomes, and on the disc margin, at the base of each sepal, is an enlarged, bilobed, probably glandular appendage. There are minute papillate trichomes on the disc appendages and on the epidermis of the anthers. These epidermal papillae, as well as the pubescent disc and bilobed appendages, are similar to features of staminate flowers in various extant American species of *Gouania*. However, the fossil is unique within family Rhamnaceae in its irregular corolla and androecium, and it stands out as an evolutionary experiment with zygomorphy in this otherwise actinomorphic family.

RESUMEN

Distigouania irregularis (Rhamnaceae) se describe como género y especie nuevos de angiosperma fósil de los depósitos de ámbar del Terciario medio de la República Dominicana, en la isla caribeña de La Española. El fósil está representado por una flor simple estaminada en antesis que muestra una corola irregular cuyos cuatro pétalos son rómbico-lanceolados, patentes, y semejantes a sépalos, mientras que el quinto es más corto, erecto, y ligeramente acopado. Los estambres son dimórficos; los 4 que están opuestos a los pétalos desplegados tienen anteras abiertas en filamentos erectos que divergen de los pétalos, mientras que el quinto estambre se acerca al pétalo erecto acopado, y tiene una antera más grande no abierta. El disco hipántico es densamente pubescente con tricomas enmarañados, y en el margen del disco, en la base de los sépalos, está un apéndice ensanchado bilobulado, probablemente glandular. Hay tricomas con papilas diminutas en los apéndices del disco y en la epidermis de las anteras Estas papilas epidérmicas, así como el disco pubescente y los apéndices bilobulados, son similares a las características de las flores estaminadas de varias especies americanas actuales de *Gouania*. Sin embargo, el fósil es único en la familia Rhamnaceae por su corola irregular y androceo, y se mantiene como un experimento evolutivo con la zigomorfía en esta familia actinomórfica por lo demás.

INTRODUCTION

Amber mines in the mountains of central Hispaniola have yielded numerous fossil flowers from Mid-Tertiary tropical forests in the Caribbean region. The present flower is the 16th species to be described from these deposits. Others are 1 species of Fabaceae (Poinar 1991), 3 of Arecaceae (Poinar 2002a, 2002b), 2 of Poaceae (Poinar & Judziewicz 2005; Poinar & Columbus 2012), 1 of Chrysobalanaceae (Poinar et al. 2008a; revised by Chambers & Poinar 2010), 2 of Lauraceae (Chambers et al. 2011a, 2012), 3 of Meliaceae (Chambers et al. 2011b; Chambers & Poinar 2012), 1 of Burseraceae (Chambers & Poinar 2013), 1 of Myristicaceae (Poinar & Steeves 2013), and 1 possibly of Moraceae (Poinar et al. 2008b). The moist forests of this period have been described by Poinar and Poinar (1999), based on numerous amber-embedded insect species together with whatever plant fossils were then available. The resin that trapped these organisms was produced by *Hymenaea protera* Poinar (Poinar 1991), a progenitor of the modern-day forest species *H. courbaril* L. Fossils of Rhamnaceae, principally leaves and fruits from the Late Cretaceous and Early Cenozoic, have been the object of numerous studies (see references in Jones & Dilcher 1980; Burge & Manchester 2008; Correa et al. 2010) and have contributed to phylogenetic and historical phytogeographic analyses of the family (Richardson et al. 2000a, 2000b, 2004).

MATERIALS AND METHODS

This and the other fossils referred to above were collected from amber mines in the Cordillera Septentrional, between Puerto Plata and Santiago, Dominican Republic. Different dates have been ascribed to the marine sediments in which the amber is found. A younger proposed age of 20–15 Ma is based on foraminifera present in the deposits (Iturralde-Vinent & MacPhee 1996). An older age of 45–30 Ma is based on marine coccoliths (Cépek in Schlee 1999). The amber is in turbiditic sandstones of the Upper Eocene to Lower Miocene Mamey Group (Draper et al. 1994). Examination and photographs were made with a Nikon stereoscopic microscope SMZ-10-R at 80× and a Nikon Optiphot microscope at 800×.

DESCRIPTION

Distigouania K.L. Chambers & Poinar, gen. nov. (**Figs. 1–5**).TYPE SPECIES: *Distigouania irregularis* K.L. Chambers & Poinar, sp. nov.

Flower staminate, pedicel glabrous, hypanthium dish-shaped, glabrous (Fig. 5), calyx radially symmetrical, sepals 5, equal, spreading (Fig. 1), corolla irregular, with 4 spreading, petals, not cupped or hooded, and 1 shorter, cupped, erect petal (Figs. 1, 3, 4), stamens dimorphic, the 4 opposite the spreading petals erect on slender filaments, with dehisced, bilocular anthers, stamen opposite the cupped petal with the anther larger, ± appressed to petal, indehiscent or possibly tardily dehiscent, disc flat, densely pubescent with tangled trichomes (Fig. 2), appendages of disc 5, enlarged, bilobed, each opposite the base of a sepal (Fig. 2), epidermis of disc appendages and anthers minutely papillate, style none. Pistillate flower unknown.

Etymology.—From Latin "disto," to stand apart, be separate, and *Gouania*, a genus of Rhamnaceae.

Distigouania irregularis K.L. Chambers & Poinar, sp. nov. TYPE: HISPANIOLA. DOMINICAN REPUBLIC: amber mine in the northern mountain ranges (Cordillera Septentrional), 1998, *unknown amber miner s.n.* (HOLOTYPE: catalogue number Sd-9-178, deposited in the Poinar amber collection maintained at Oregon State University, Corvallis, Oregon 97331, U.S.A.)

Sepals glabrous, ovate, 0.9–1.2 mm long, 0.7–0.8 mm wide, tip acute to acuminate, not thickened, midline ridged (Figs. 1, 2), corolla glabrous, the 4 spreading petals rhomboid-lanceolate, 0.7–0.9 mm long, 0.4–0.5 mm wide, acute (Fig. 1), 5th petal obovate, obtuse, ca. 0.4 mm long, 0.35 mm wide, slightly cupped (Figs. 1, 3, 4), filaments of 4 erect, dehiscent stamens 0.014–0.027 mm long, valves of dehisced anthers 0.023–0.030 mm long, 0.013–0.018 mm wide (Figs. 2, 3), undehisced anther valves of 5th stamen ca. 0.032 mm long, 0.022 mm wide (Fig. 3), filament of undehisced anther ca. 0.015 mm, disc appendages 0.025–0.028 mm wide, 0.018–0.022 mm long (Fig. 2), pedicel 1.2 mm long.

Etymology.—From Latin "irregularis," divisible into 2 equal halves along one plane only.

DISCUSSION

Our original comparison of the fossil was with *Gouania*, a pantropical genus of ca. 50 species (Medan & Schirarend 2004; Pool 2014). Examination of published illustrations and a limited sample of herbarium specimens has not shown any examples of irregular corollas or anthoecia, nor do standard descriptions of the genus mention these floral features. In such a large genus, it is not inconceivable that irregular flowers may have evolved in some extant species; however, if present, they seem to have escaped notice. With respect to a shallow hypanthium, small petals cupping the anthers, a flat, pubescent disc, bilobed disc appendages, and lack of a style in staminate flowers, the fossil resembles *Gouania* taxa such as *G. hypoglauca* Standl., a Central American species. A review of *Gouania* in the Caribbean, Mexico, and Central America was recently published by Pool (2014), giving a basis for comparing *Distigouania* with modern species of this region. Treatments of the Rhamnaceae as a whole (e.g., Sussenguth 1953; Medan & Schirarend 2004) describe the family as having radially symmetrical flowers. This fossil is so unusual in its floral structure, therefore, that we believe it merits description as a separate genus.

A feature of the flower not yet remarked on is the strong similarity of the 4 laterally spreading petals to the sepals. Except for being smaller, these petals are like the sepals in their shape and textural appearance, as fossilized. Their color, in life, may also have been sepal-like. A further similarity is the presence of a partial mid-

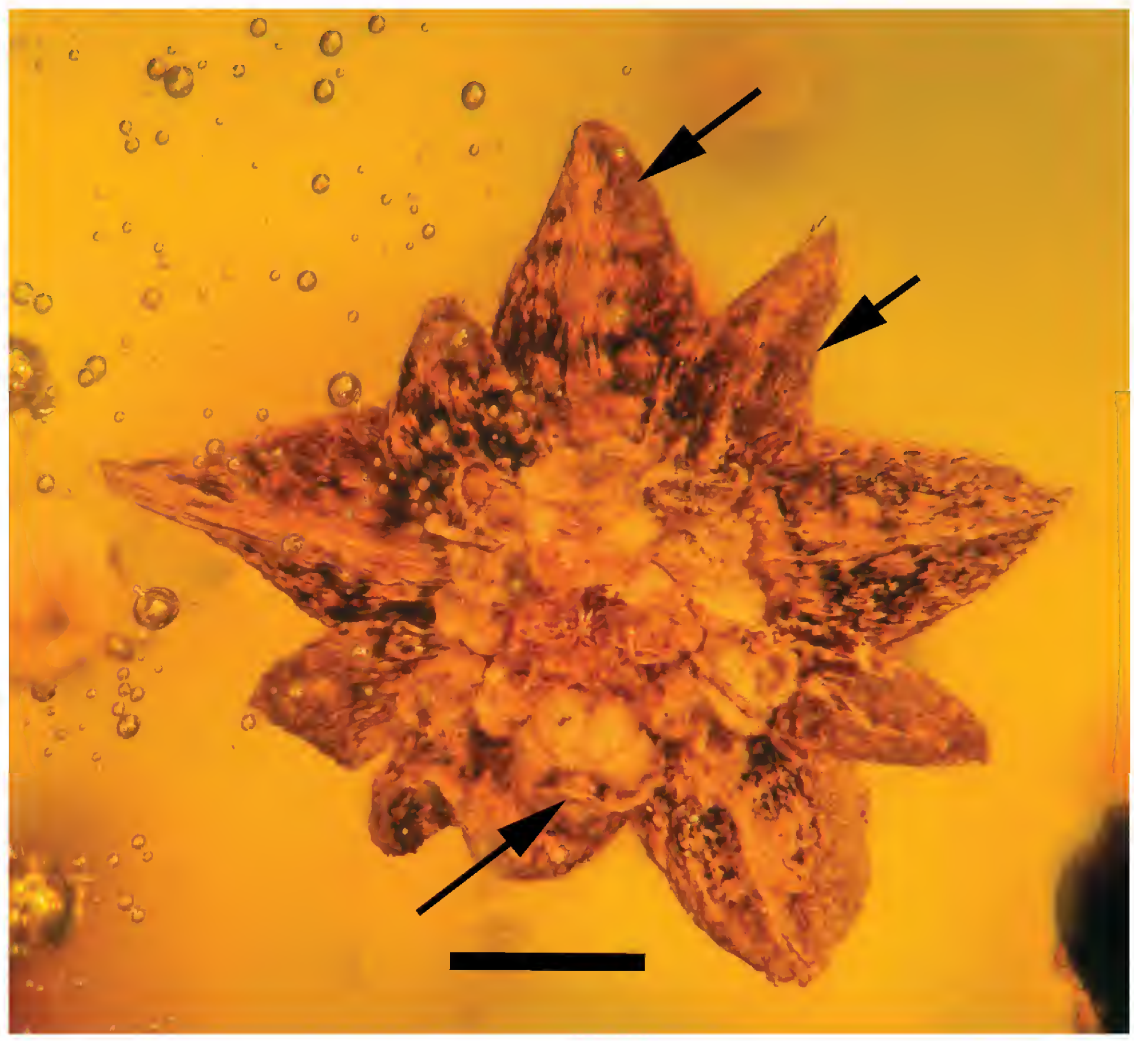


Fig. 1. *Distigouania irregularis*. Apical view of flower. Upper arrow is on sepal, middle arrow indicates one of the 4 spreading petals, lower arrow shows erect, cupped petal. Note ridge on sepal midline. Scale bar = 0.7 mm.

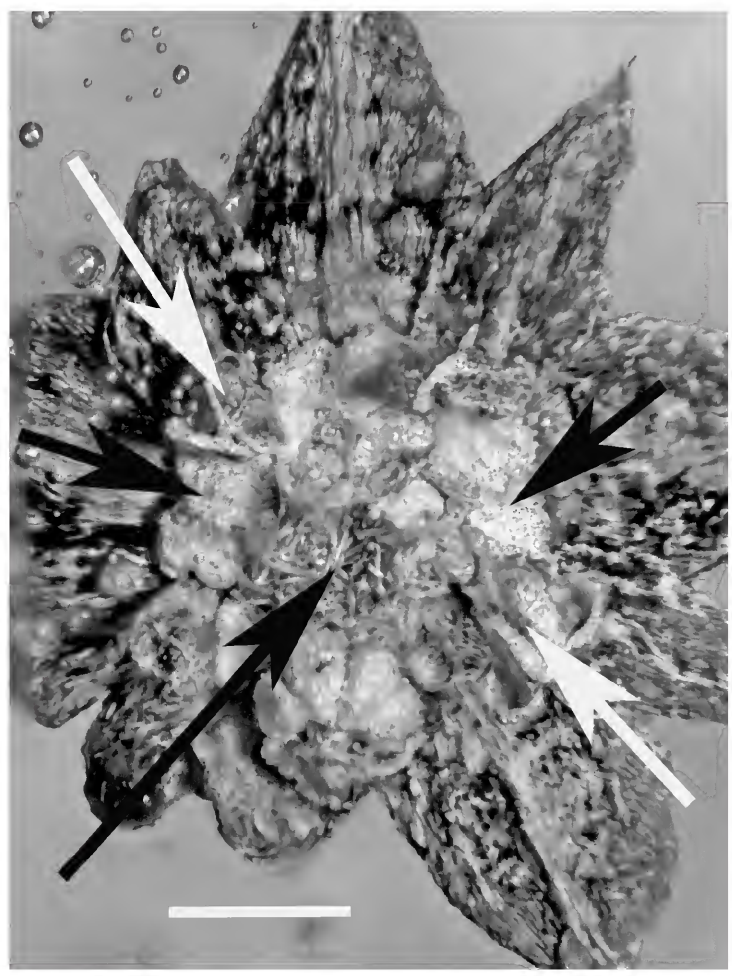


Fig. 2. *Distigouania irregularis*. Enlarged apical view. Long black arrow indicates tangled trichomes on hypanthial disc, 2 short black arrows are on bilobed disc appendages, white arrows point to 2 dehisced anthers. Scale bar = 0.49 mm.

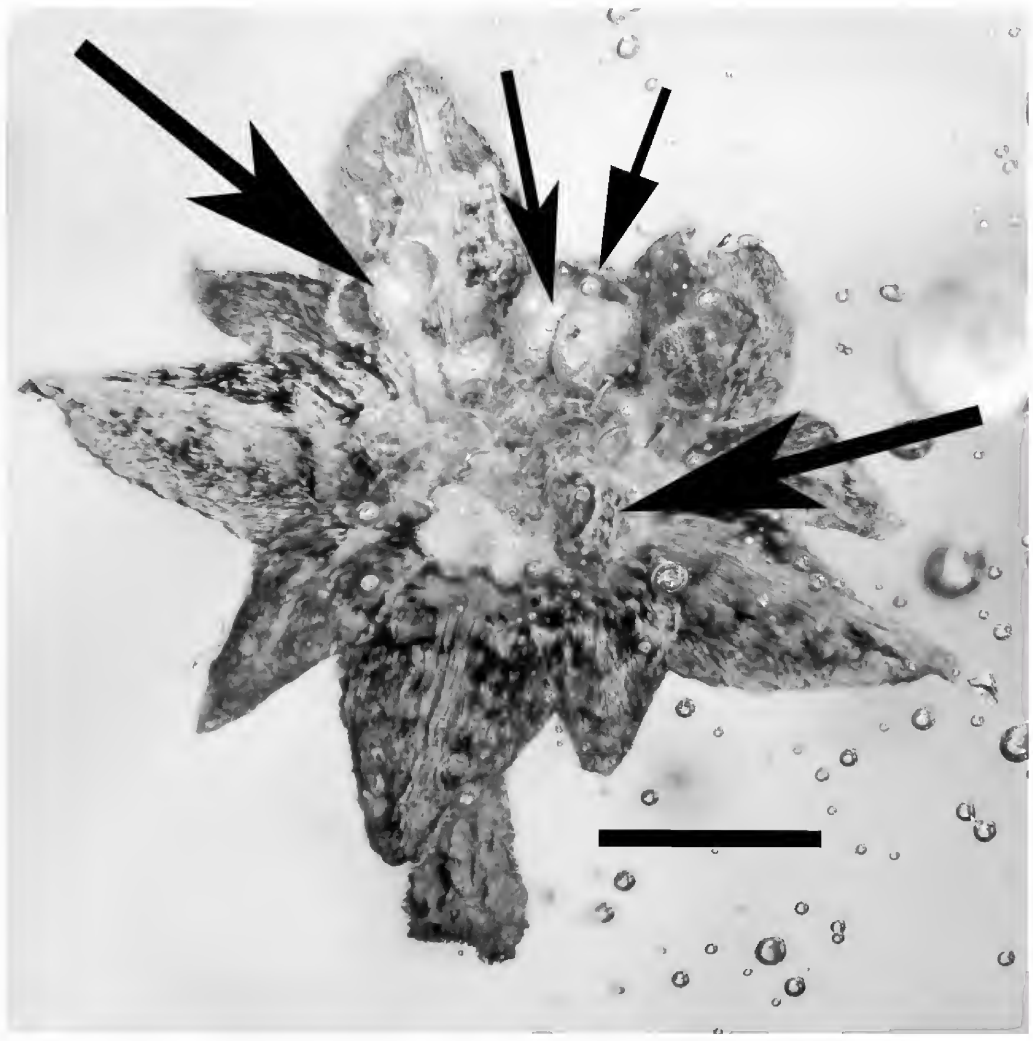


Fig. 3. *Distigouania irregularis.* Apical view. Long arrows are on dehisced anthers, short arrow, top middle, points to undehisced anther, shortest arrow, top right, indicates cupped petal subtending this anther. Scale bar = 0.675 mm.

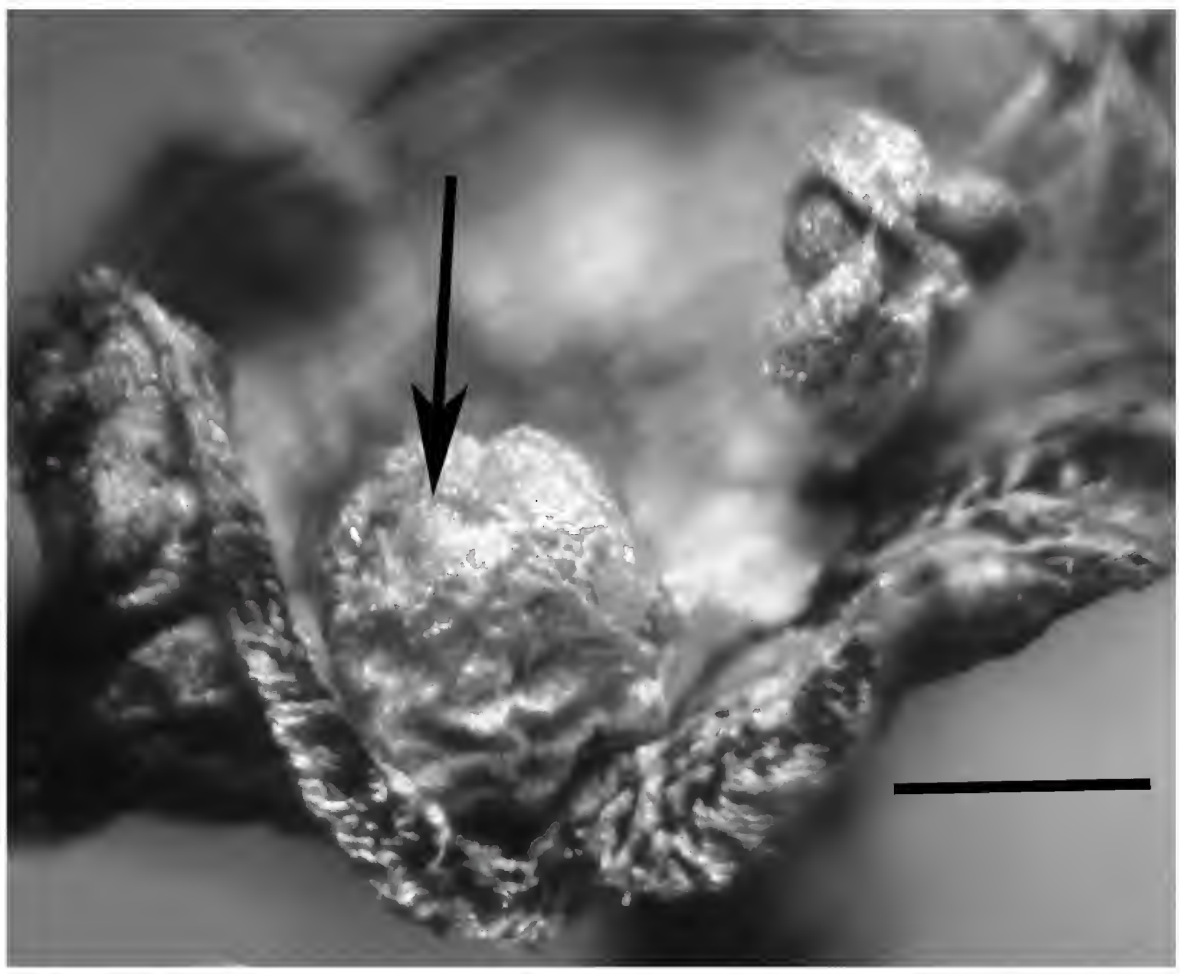


Fig. 4. *Distigouania irregularis.* Lateral view. Arrow indicates the erect petal, which is cupped and subtends the stamen with undehisced anther. Scale bar = 0.26 mm.

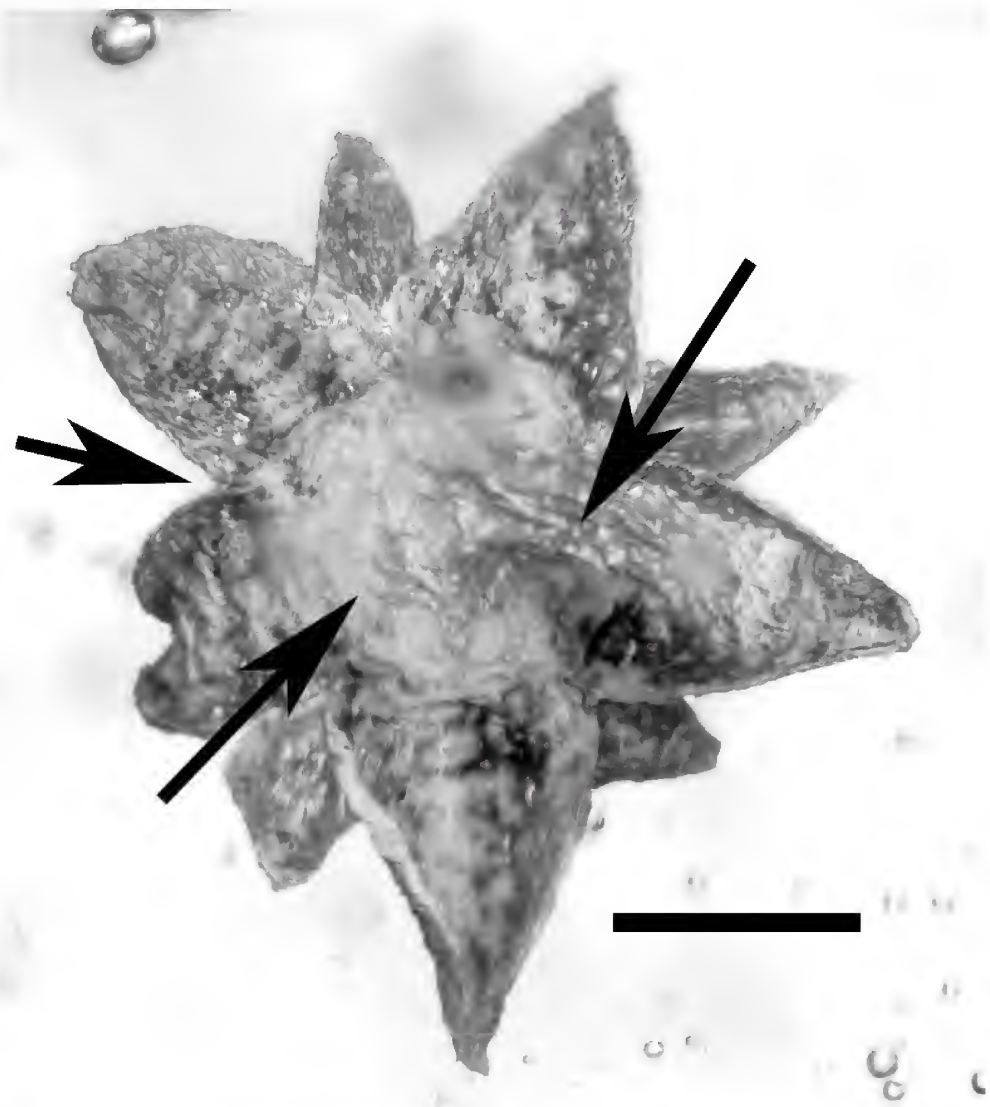


Fig. 5. ***Distigouania irregularis*****. Basal view. Right arrow is on pedicel, upper left arrow indicates location of 5th, non-spreading petal, lower arrow is on hypanthium. Scale bar = 0.736 mm.**

line ridge, visible in the proximal half of petals in the 2 o'clock and 4 o'clock positions in Figure 1. The 5th petal, erect and cupped against the undehisced anther (Fig. 1, lower arrow, Fig. 4) is like the limb of a typical petal of Rhamnaceae in size, shape, and texture. At a developmental- genetic level we speculate that the sepaloid appearance of 4 of the second whorl organs could result from the partial loss of expression of B class genes in this whorl (from the ABC model of flower development, see Bowman et al. 1989; Theissen et al. 2000), as occurs in a variety of extant taxa (e.g., Kramer et al. 2003). Additionally, loss of radial symmetry and petal showiness could result from changes in the expression pattern of flower symmetry genes (Preston et al. 2011). Therefore, if extant members of Rhamnaceae with a similar phenotype were found, it could lead to interesting comparative studies of the genetics of candidate genes for flower development, such as orthologs of *PISTILLATA, APETALA3, CYCHLOIDEA* and *DICHOTOMA*. We might then come closer to explaining the morphology of this unusual Mid-Tertiary fossil.

If allied to *Gouania*, as hypothesized, *Distigouania* is a member of Tribe Gouanieae (Richardson et al. 2000a:333; Medan & Schirarend 2004:330). In a molecular phylogenetic analysis of Rhamnaceae using the plastid genes *rbcL* and *trnL-F*, Richardson et al. (2000b) found 3 well-supported clades; however, these could not be characterized morphologically, at least with presently available data. They were given the informal names of the *rhamnoid clade*, the *ampeloziziphoid clade*, and the *ziziphoid clade*. Gouanieae belong to the *ziziphoid clade* as a well-supported, monophyletic group, consisting of *Crumenaria, Gouania, Helinus, Pleuranthodes*, and *Reissekia*. In their discussion of the biogeography of Rhamnaceae, these authors propose a phylogeny extending back to the Mid-Cretaceous with possible relationships to the Rose Creek flower of Basinger and Dilcher (1984), which may establish 94–96 Ma as the minimum age of the family.[1] For some genera, at least, a

[1]Assigning the Rose Creek flower to Rhamnaceae is not accepted by some other authorities, however (Calvillo-Canadell & Cevallos-Ferriz 2007:1667).

widespread Old and New World distribution may be attributed to their ancestors' initial presence in Gondwanaland prior to its breakup. The occurrence of modern genera of Rhamnaceae in the late Cretaceous has not yet been firmly established in the fossil record. Flowers of this family, not specifically assignable to an extant genus, were discovered in Mexican strata of probable late Campanian age, ca. 74 Ma (Calvillo-Canadell & Cevallos-Ferriz 2007). Upper Maastrichtian leaves of *Berhamniphyllum* (Jones & Dilcher 1980; Correa et al. 2010) are similar to those of *Rhamnidium* and *Berchemia*, while the winged fruit of *Archeopaliurus* (Correa et al. 2010) compares well with that of *Paliurus*. Taking into account both fossil and molecular evidence, Calvillo-Canadell and Cevallos-Ferriz (op. cit.) propose an Eocene/Oligocene origin for genera such as *Gouania, Ziziphus, Berchemia*, *Karwinskia*, and *Paliurus*.

The present fossil, from the Oligocene or early Miocene, stands out as an evolutionary experiment with zygomorphic flowers in this otherwise actinomorphic family. Because floral zygomorphy is frequently associated with insect pollination, we suggest that the notably enlarged, bilobed appendages of the hypanthial disc may have been nectariferous, supplying a reward for insect visitors. The function of the undehisced anther, which stayed closed while the other 4 anthers opened and released their pollen, remains unexplained. Given the absence of living relatives having a comparable floral syndrome, we choose not to speculate on whether, in this species, it also may have had a particular function in insect pollination.

ACKNOWLEDGMENTS

We thank the herbaria of Harvard University, the New York Botanical Garden, and the Missouri Botanical Garden for lending us specimens for this study. Amy Pool, Richard Abbott, and Barbara Rye provided useful observations and suggestions. Verónica Di Stilio was our consultant in developmental floral genetics and helped to prepare the paragraph on that subject in the Discussion section.

REFERENCES

Basinger, J. & D. Dilcher. 1984. Ancient bisexual flowers. Science 224:511–513.

Bowman, J.L., D.R. Smyth, & E.M. Meyerowitz. 1989. Genes directing flower development in *Arabidopsis*. Plant Cell 1:37–52.

Burge, D.O. & S.R. Manchester. 2008. Fruit morphology, fruit history and biogeography of *Paliurus* (Rhamnaceae). Int. J. Pl. Sci. 169:1066–1085.

Cavillo-Canadell, L. & S. Cevallos-Ferriz. 2007. Reproductive structures of Rhamnaceae of Cerro del Pueblo (Late Cretaceous, Coahuila) and Coatzingo (Oligocene, Puebla) Formations, Mexico. Amer. J. Bot. 94:1658–1669.

Chambers, K.L. & G.O. Poinar, Jr. 2010. The Dominican amber fossil *Lasiambix* (Fabaceae: Caesalpinioideae?) is a *Licania* (Chrysobalanaceae). J. Bot. Res. Inst. Texas 4:217–218.

Chambers, K.L. & G.O. Poinar, Jr. 2012. A Mid-Tertiary fossil flower of *Swietenia* (Meliaceae) in Dominican amber. J. Bot. Res. Inst. Texas 6:123–127.

Chambers, K.L., G.O. Poinar, Jr., & A.E. Brown. 2011a. A fossil flower of *Persea* (Lauraceae) in Tertiary Dominican amber. J. Bot. Res. Inst. Texas 5:457–462.

Chambers, K.L., G.O. Poinar, Jr., & A.E. Brown. 2011b. Two fossil flowers of *Trichilia* (Meliaceae) in Dominican amber. J. Bot. Res. Inst. Texas 5:463–468.

Chambers, K.L., G.O. Poinar, Jr., & A.S. Chanderbali. 2012. *Treptostemon* (Lauraceae), a new genus of fossil flower from Mid-Tertiary Dominican amber. J. Bot. Res. Inst. Texas 6:551–556.

Chambers, K.L. & G.O. Poinar, Jr. 2013. A fossil flower of the genus *Protium* (Burseraceae) in mid-Tertiary amber from the Dominican Republic. J. Bot. Res. Inst. Texas 7:367–373.

Correa, E., C. Jaramillo, S. Manchester, & M. Gutierrez. 2010. A fruit and leaves of Rhamnaceous affinities from the late Cretaceous (Maastrichtian) of Colombia. Amer. J. Bot. 97:71–79.

Draper, G., P. Mann, & J.F. Lewis. 1994. Hispaniola. In: S. Donovan & T.A. Jackson, eds. Caribbean geology: an introduction. The University of the West Indies Publishers' Association, Kingston, Jamaica. Pp. 129–150.

Iturralde-Vinent, M.A. & R.D.E. MacPhee. 1966. Age and paleogeographic origin of Dominican amber. Science 273: 1850–1852.

Jones, J.H. & D.L. Dilcher. 1980. Investigations of angiosperms from the Eocene of North America: *Rhamnus marginatus* (Rhamnaceae) reexamined. Amer. J. Bot. 67:959–967.

Kramer, E.M., V.S. Di Stilio, & P.M. Schlüter. 2003. Complex patterns of gene duplication in the *apetala3* and *pistillata* lineages of the Ranunculaceae. Int. J. Pl. Sci. 164:1–11.

Medan, D. & C. Schirarend. 2004. Rhamnaceae. In: K. Kubitzki, ed. The families and genera of vascular plants. VI. Flowering plants - Dicotyledons. Springer-Verlag, Berlin, Germany. Pp. 320–338.

Poinar, G.O., Jr. 1991. *Hymenaea protera* sp. n. (Leguminosae: Caesalpinioideae) from Dominican amber has African affinities. Experientia 47:1075–1082.

Poinar, G.O., Jr. & R. Poinar. 1999. The amber forest. Princeton University Press, Princeton, New Jersey, U.S.A.

Poinar, G.O., Jr. 2002a. Fossil palm flowers in Dominican and Mexican amber. Bot. J. Linn. Soc. 138:57–61.

Poinar, G.O., Jr. 2002b. Fossil palm flowers in Dominican and Baltic amber. Bot. J. Linn. Soc. 139:361–367.

Poinar, G.O., Jr. & E.J. Judziewicz. 2005. *Pharus primuncinatus* (Poaceae: Pharoideae: Phareae) from Dominican amber. Sida 21:2095–2103.

Poinar, G.O., Jr., K.L. Chambers, & A.E. Brown. 2008a. *Lasiambix dominicensis* gen. and sp. nov., a eudicot flower in Dominican amber showing affinities with Fabaceae subfamily Caesalpinioideae. J. Bot. Res. Inst. Texas 2:463–471.

Poinar, G.O., Jr., K.L. Chambers, & A.E. Brown. 2008b. *Trochanthera lepidota* gen. and sp. nov., a fossil angiosperm inflorescence in Dominican amber. J. Bot. Res. Inst. Texas 2:1167–1173.

Poinar, G.O., Jr. & J.T. Columbus. 2012. *Alarista succina* gen. et sp. nov. (Poaceae: Bambusoideae) in Dominican amber. Historical Biol. 1–6.

Poinar, G.O., Jr. & R. Steeves. 2013. *Virola dominicana* sp. nov. (Myristicaceae) from Dominican amber. Botany 91:530–534.

Pool, A. 2014. Taxonomic revision of *Gouania* of North America. Ann. Missouri Bot. Gard. 99:490–552.

Preston, J.C., C.C. Martinez, & L.C. Hileman. 2011. Gradual disintegration of the floral symmetry gene network is implicated in the evolution of a wind-pollination syndrome. Proc. Natl. Acad. Sci. 108:2343–2348.

Richardson, J.E., M.F. Fay, Q.C.B. Cronk, & M.W. Chase. 2000a. A revision of the tribal classification of Rhamnaceae. Kew Bull. 55:311–340.

Richardson, J.E., M.F. Fay, Q.C.B. Cronk, D. Bowman, & M.W. Chase. 2000b. A phylogenetic analysis of Rhamnaceae using *rbcL* and *trnL-F* plastid DNA sequences. Amer. J. Bot. 87:1309–1324.

Richardson, J.E., L.W. Chatrou, J.B. Mols, R.H.J. Erkens, & M.D. Pirie. 2004. Historical biogeography of two cosmopolitan families of flowering plants: Annonaceae and Rhamnaceae. Phil. Trans. Roy. Soc., B, Biol. Sci. 359:1495–1508.

Schlee, D. 1999. Das Bernstein-Kabinett. Stuttgarter Betr. Naturk. Ser. C, 28.

Sussenguth, K. 1953. Rhamnaceae. In: H. Melchior & E. Werdermann, eds. Engler & Prantl's Die Natürlichen Pflanzenfamilien, Band 20d, Duncker & Humblot, Berlin, Germany. Pp. 7–173.

Theissen, G., A. Becher, A. Di Rosa, A. Kanno, J.T. Kim, T. Münster, K-U. Winter, & H. Saedler. 2000. A short history of MADS-box genes in plants. Pl. Molec. Biol. 42:115–149.

BOOK REVIEW

Roy L. Lehman. 2013. **Marine Plants of the Texas Coast.** (ISBN-13: 978-1-62349-016-4, flexbound). Texas A&M University Press, 4354 TAMU, College Station, Texas 77843-4354, U.S.A. (**Orders:** www.tamu-press.com, 1-800-826-8911). $32.00, 205 pp., 264 color photos, map, bibliography, index, 6" × 9".

This 205-page book is an important resource for amateur plant enthusiasts, biologists, conservationists, students, and others with a special interest in coastal ecosystems and natural resources. It includes narrative descriptions, color photos, and specific information on a total of 140 individual species representing 81 genera from 52 families.

A logical, well organized, straightforward, and user-friendly key provides a useful tool to aid in identification of the plants included in the book. One of the details that I found most helpful and practical to a broad audience is that all measurements are listed first in English increments and followed by the metric equivalent in parentheses. The book is organized into four distinct plant groupings: shoreline plants, seagrasses, mangroves, and seaweeds.

The section on shoreline plants includes a small number of the most significant/common grasses, sedges, rushes, and forbs that provide a buffer between the tidal waters and the coastal marshes. Many of these are halophytes (salt-tolerant species) that survive and thrive in the hostile environment of the Texas coast where they are subject to high salinity, periodic inundation, wind and wave action, and harsh xerophytic conditions at times.

The seagrass section contains information about some of the most common seagrasses found in the shallow waters of the coast. In reality, these are not grasses; rather they are submerged aquatic species that have a similar appearance to terrestrial grasses and sedges.

Mangroves are woody species with specialized structural and seed dispersal properties that occur in the muddy tidal flats and shallow tidal waters. They perform many important functions including stabilization of the soil. They also trap debris, filter runoff, and prevent terrestrial organic matter from reaching the coastal waters. Mangroves and seagrasses serve as nurseries and essential habitat for fish, shellfish, and aquatic invertebrates.

The last half of the book is dedicated entirely to seaweeds (macroalgae) of the Texas coastal waters. This section includes 86 species and 45 genera and is subdivided into three subcategories based on color: red, brown, or green. While I have no knowledge and little interest in seaweed, this is apparently one of the most comprehensive discussions of that subject that has been published in a book intended for general use by a wide audience.

The appendices include a glossary and a section on plant collection and preparation techniques. I found the glossary to be very helpful for those, like me, who are not familiar with botanical terminology that is specific to aquatic vegetation and ecosystems. The discussion of plant collection and preparation techniques would be especially useful to those who are collecting and preparing specimens of marine plants. And the color photographs are an interesting and helpful addition to the information provided for each species.

The sections on seagrasses and mangroves were appropriate and provided adequate information on those plant categories. I would have preferred the book to include more species of the major shoreline plants, particularly the grasses and sedges, and much less coverage of the seaweeds. However, this book would be a valuable tool for anyone with an interest in the vegetation of the Texas coast.—*Dan Caudle, Independent Grassland Consultant, Weatherford, Texas, U.S.A.*

TICODENDRON PALAIOS SP. NOV. (TICODENDRACEAE), A MID-TERTIARY FOSSIL FLOWER IN DOMINICAN AMBER

Kenton L. Chambers

Department of Botany and Plant Pathology
Oregon State University
Corvallis, Oregon 97331, U.S.A.
chamberk@science.oregonstate.edu

George O. Poinar, Jr.

Department of Integrative Biology
Oregon State University
Corvallis, Oregon 97331, U.S.A.
poinarg@science.oregonstate.edu

ABSTRACT

Ticodendron palaios is described as a new species of fossil flower preserved in amber from Mid-Tertiary deposits in the Dominican Republic. The genus, newly described in 1989 (Gómez-Laurito & Gómez-P. 1989), is arborescent and limited to regions of wet primary forests in Central America, ranging from southern Mexico to Panama. It was made a separate family, Ticodendraceae, by Gómez-Laurito and Gómez-P. (1991) and assigned to the hamamelidalian order Fagales. The fossil species is represented by a single pistillate flower and consists of a partial inflorescence with 1 short-pedicelled, inferior ovary subtended by 4 large bracts and surmounted by 3 short sepals and 2 papillate styles. The sepals, ovary, and pedicel are densely hispid-setose. The flower shows an overall resemblance to the original species, *T. incognitum*, with some important differences, one being that its styles, instead of being extended, are appressed to the ovary. However, this could be due to the flower's position at the edge of the resin exudate before it was fossilized.

RESUMEN

Se describe **Ticodendron palaios** como una nueva especie fósil de flor preservada en ámbar en depósitos del Terciario medio en la República Dominicana. El género, descrito en 1989 (Gómez-Laurito & Gómez-P. 1989), es arborescente y limitado a las regiones de bosques primarios húmedos en América Central, que van del sur de México a Panamá. Se hizo una nueva familia, Ticodendraceae, por Gómez-Laurito y Gómez-P. (1991) y se assignó al orden Fagales de las hamamelidas. La especie fósil está representada por una flor simple pistilada y consiste en una inflorescencia parcial con un ovario ínfero cortamente pedicelado, subtendido por 4 grandes brácteas y sobremontado por tres cortos sépalos y dos estilos 2 papilados. Los sépalos, ovario, y pedicelo son densamente híspido-setosos. La flor muestra un parecido general con la especie original, *T. incognitum*, con algunas diferencias importantes, una son sus estilos, que en vez de ser patentes, son apresados al ovario. Sin embargo, esto puede estar debido por la posición de la flor en el borde del exudado de resina antes de fosilizarse.

INTRODUCTION

Dominican amber is obtained from mines in the mountains of central Hispaniola and contains fossilized plant materials and animals, especially insects, which make it sought after by collectors. The marine strata containing the amber have been placed in the Mid-Tertiary period, but the exact dating is uncertain, due to two different published estimates derived from fossil organisms in the deposits. An age of 20–15 Ma was proposed (Iturralde-Vinent & MacPhee 1996) based on foraminifera, while studies of coccoliths yielded an estimate of 45–30 Ma (Cépek in Schlee 1999). The strata are composed of turbiditic sandstones of the Upper Eocene to Lower Miocene Mamey Group (Draper et al. 1994).

The resin giving rise to the amber was produced by a leguminous tree, *Hymenaea protera* (Poinar 1991), a relative of the present-day Neotropical species *H. courbaril* L. The suite of amber-embedded organisms is representative of a moist tropical forest, which was described by Poinar and Poinar (1999) based on the known insect fauna together with whatever plant fossils were then available. The present flower is the 17th angiosperm species to be described from Dominican amber. Others are 1 species of Fabaceae (Poinar 1991), 3 of Arecaceae (Poinar 2002a, 2002b), 2 of Poaceae (Poinar & Judziewicz 2005, Poinar & Columbus 2012), 1 of Chrysobalanaceae (Poinar et al. 2008a, revised by Chambers & Poinar 2010), 2 of Lauraceae (Chambers et al. 2011a, 2012), 3 of Meliaceae (Chambers et al. 2011b, Chambers & Poinar 2012), 1 of Burseraceae (Chambers & Poinar 2013), 1 of Myristaceae (Poinar & Steeves 2013), 1 of Rhamnaceae (Chambers & Poinar 2014), and 1 possibly of Moraceae (Poinar et al. 2008b).

Our proposal to place the fossil in *Ticodendron* came from its similarity to illustrations and descriptions of *T. incognitum* published in Kubitzki (1993), and this relationship was later confirmed by examination of herbarium specimens. *Ticodendron* which was formally described only recently (Gómez-Laurito & Gómez-P. op. cit.) is a dioecious, arborescent, monotypic genus occurring in moist tropical forests of Central America, from southern Mexico to Panama. It had been collected infrequently in the past and was most often mistaken for *Alnus*, due to a similarity in leaf architecture (Hickey & Taylor 1991). The small, unisexual flowers were not well understood by earlier taxonomists, who were unable to place them in a known genus. Discovery of a fossil species of *Ticodendron*, if correctly assigned,, will help in understanding the history of the family and of the Tertiary Laurasian forests of which it is characteristic (Hammel & Burger 1991). These relationships are discussed in a later section.

MATERIALS AND METHODS

The fossil is contained in a rectangular block of amber measuring 8 × 4 × 4 mm. It was obtained from mines in the Cordillera Septentrional, between Puerto Plata and Santiago, Dominican Republic. Examination and photographs were made with a Nikon stereoscopic microscope SMA-10-R at 80× and a Nikon Optiphot microscope at 800×.

DESCRIPTION

Ticodendron palaios K.L. Chambers & Poinar, sp. nov. (**Figs. 1–2**). TYPE: HISPANIOLA. DOMINICAN REPUBLIC: amber mine in the northern mountain range (Cordillera Septentrional), 2013, *unknown amber miner s.n.* (HOLOTYPE: catalogue number Sd-9-192, deposited in the Poinar amber collection maintained at Oregon State University, Corvallis, Oregon 97331, U.S.A.).

Flower single, pistillate, in a peduncled partial inflorescence (Tobe 1991), peduncle 1.9 mm long, lightly hispid, arising from a terminal or axillary bud with numerous, spirally arranged bud scales (Fig. 1), bracts subtending inflorescence 4, separate, lanceolate, acute, up to 1.9 mm long, 0.6 mm wide, glabrous (Figs. 1, 2), axillary scales, if any, not visible, ovary inferior, oblong-cylindric, 2.8 mm long, 1.5 mm wide, densely hispid-setose (Figs. 1, 2), pedicelled, pedicel 0.8 mm long, hispid-setose (Fig. 2), sepals 3 (2 visible), 0.7 mm long, 0.4 mm wide, oblong-lanceolate, obtuse, hispid-setose abaxially (Fig. 2), petals 0, styles 2 (?), densely papillate (Fig. 2), probably stigmatic throughout, unnaturally appressed to apex of ovary due to position of flower in the block of amber; staminate inflorescence unknown.

Etymology.—From Greek "palaios," ancient.

DISCUSSION

The apex of the flower is pressed against the edge of the block of amber (see Fig. 2), and there are an air bubble and granular artifact on one side (Fig. 1) that make interpretation of the styles and perianth difficult. Two sepals are evident in the other lateral view (Fig. 2), and the base of one folded-over style can be seen between them, bending sideways across the flower apex (Fig. 2). The styles otherwise can't be observed or measured. Air bubbles are present among the bracts (Figs. 1, 2), but these do not interfere with an interpretation of the inflorescence.

There are a number of significant differences between *Ticodendron palaios* and the extant species, *T. incognitum*. In the latter taxon, the inflorescence does not arise directly from a basal bud. Instead, it is terminal on a short lateral branch at whose tip is a pair of bracteate leaves (Gómez-Laurito & Gómez-P. 1989, Fig. 6F). Also, the two lower bracts subtending the flower are connate basally and a third bract is separate and displaced upward (pers. observ.); all 3 are densely strigillose-pubescent abaxially and glabrous adaxially (pers. observ.). In the fossil species, the bracts are 4, distinct throughout, and glabrous on both sides. The flower of *T. incognitum* is sessile, whereas in *T. palaios* it is borne on a short pedicel. The pubescence of the ovary in the extant species is lightly appressed-pilose, but in the fossil, it is densely hispid-setose. The sepals in *T. incognitum* are abundantly pilose-hispid adaxially, and these trichomes persist around the base of the styles in the developing fruit (pers. observ.). No such pubescence is seen in *T. palaios*. Leaf morphology, as well as the nature of the staminate inflorescence, is unknown in *T. palaios*, so that further comparisons with *T. incognitum* are not possible at present.

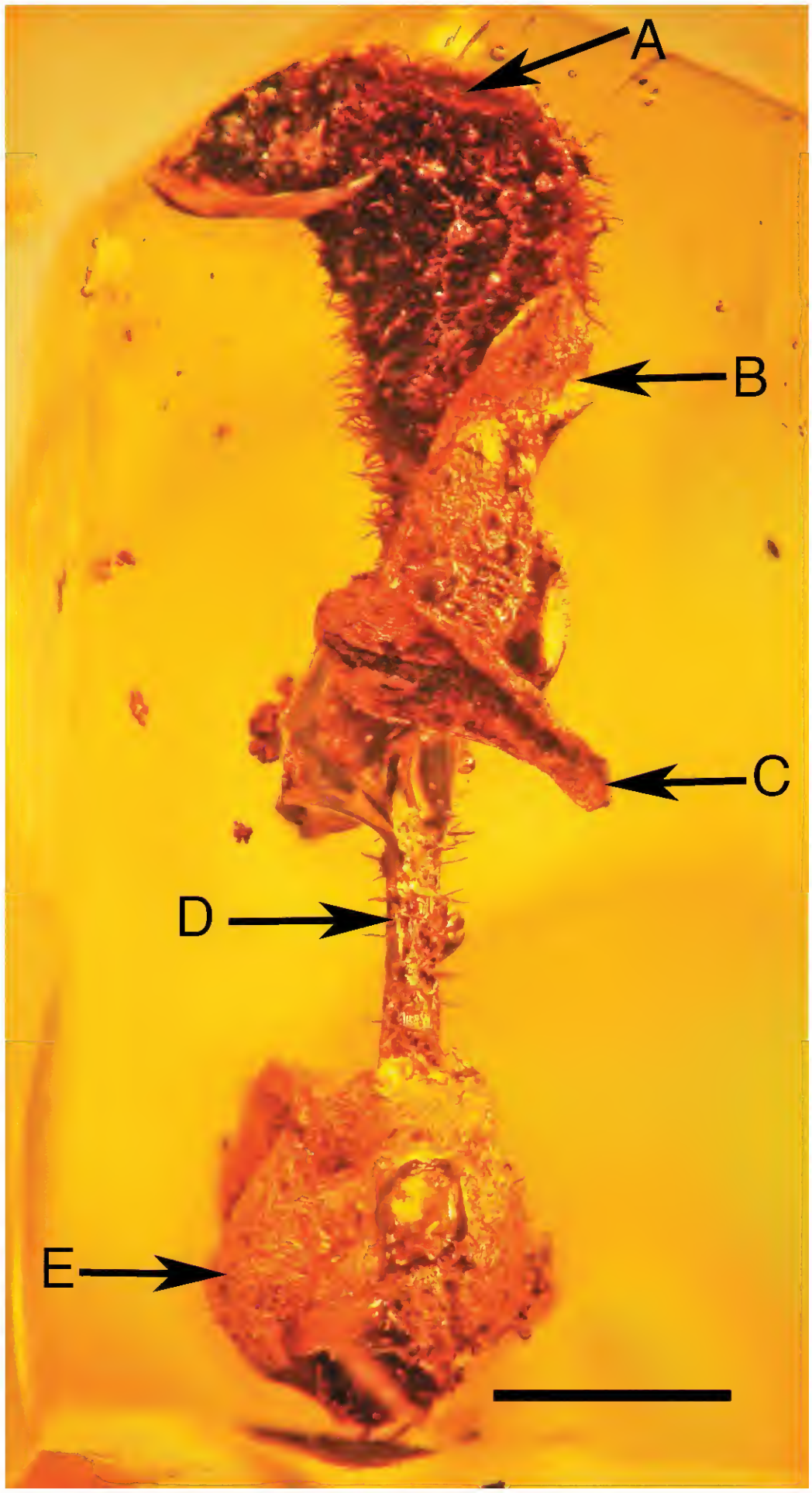


Fig. 1. *Ticodendron palaios.* **A:** Terminal portion of one style lying over top of ovary. **B** and **C:** 2 of the 4 bracts subtending the flower. **D:** Peduncle of the inflorescence. **E:** Scale of the basal bud. The air bubble and granular material at upper left are artifacts. Scale bar = 1.3 mm.

The anatomy, morphology, and relationships of *Ticodendron* were the subject of a series of papers published shortly after the genus was first described (Behnke 1991; Carlquist 1991; Feuer 1991; Hammel & Burger 1991; Hickey & Taylor 1991; Tobe 1991). The species had been collected a number of times in Central America, but it was not recognized as a unique genus until its alder-like leaves were brought together with its incon-

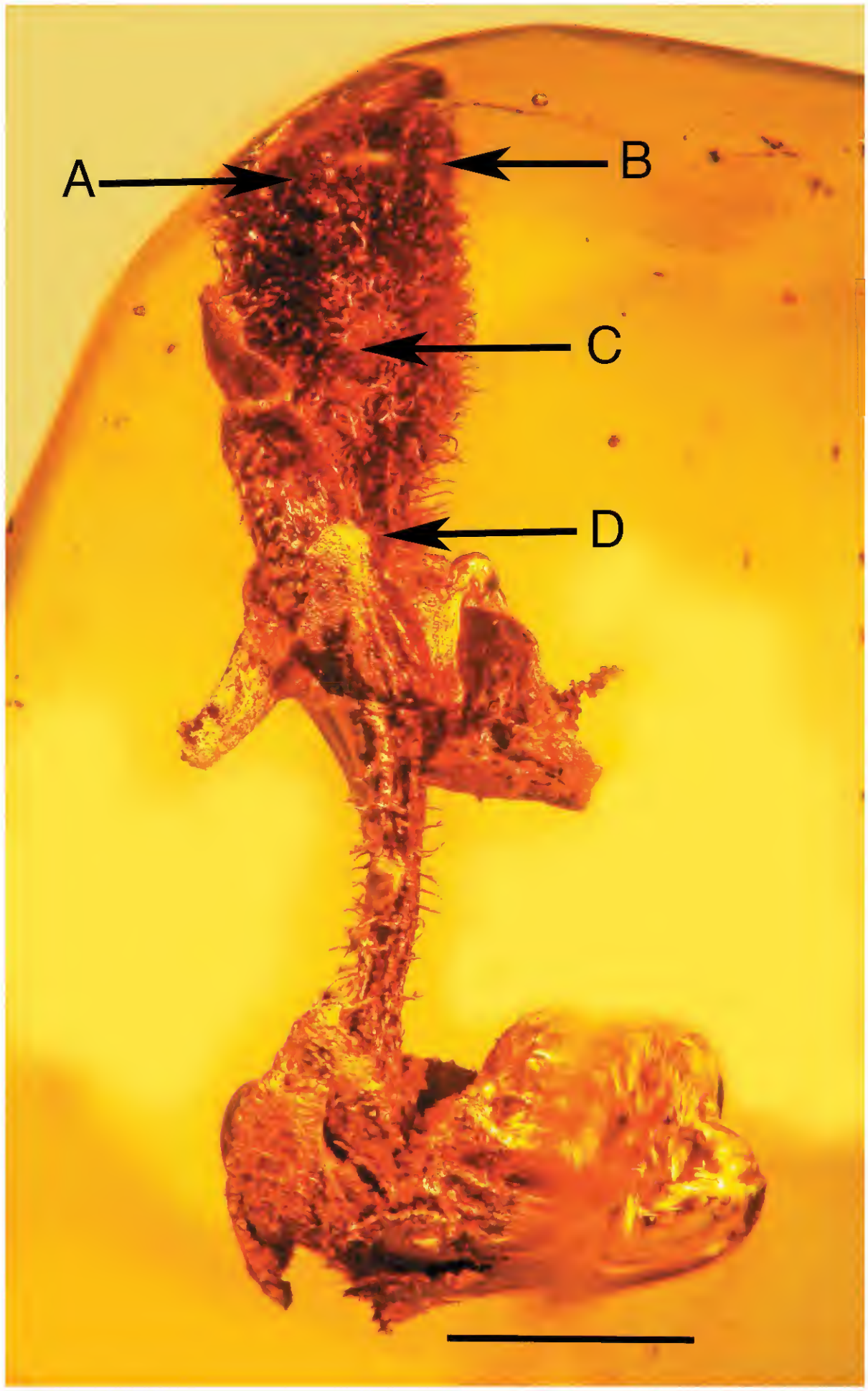


Fig. 2. *Ticodendron palaios*. Reverse lateral view of inflorescence. **A:** base of style. **B:** 1 of 2 visible sepals. **C:** ovary. **D:** floral pedicel. Scale bar = 1.5 mm.

spicuous male and female inflorescences by Gómez-Laurito and Gómez-P. (1989). The authors writing in 1991, above, considered several possible taxonomic orders in which to place the genus, including Juglandales, Myricales, Fagales, and Urticales. The totality of its wood and bark anatomy, pollen morphology, phloem sieve-elements, leaf architecture, and floral morphology led to its being classified as a monotypic family in order Fagales (Gómez-Laurito & Gómez-P. 1991).

Ecological relationships of the modern species, *Ticodendron incognitum,* were given special attention by Hammel and Burger (1991), who noted its occurrence in diverse, moist, evergreen cloud forests of middle-elevations, found on both sides of the continental divide throughout Mesoamerica. According to these authors, the fossil history of associated taxa indicates that they are members of a once widespread northern (Laurasian) forest flora of the Tertiary Period (Hammel & Zamora 1990). Studies of the leaf architecture of *T. incognitum* by Hickey and Taylor (1991) suggested a relationship with an Oligocene fossil taxon from Colorado, the genus *Fagopsis* (Manchester & Crane 1983). This relationship was confirmed in cladistic analyses of 48 principally vegetative characteristics (Hickey & Taylor, op. cit., Figs. 19–22). Even more convincing is its relationship to the Middle Eocene fossil fruit *Ferrignocarpus bivalvis* from the Clarno Formation in Oregon, assigned to Ticodendraceae by Manchester (2011). In this paper, Manchester also described identical fruits from the Early Eocene London Clay flora in England, which had been informally named "*Carpolithus* sp. 38" by Reid and Chandler (1933). In his discussion, Manchester (op. cit.) noted that this bicontinental disjunction "implies that the genus spread across higher latitudes and via the North Atlantic land bridge during the Late Paleocene and/or Early Eocene, when climatic conditions were suitable for the establishment of thermophilic taxa farther north." This analysis parallels the observations by Hammel and Burger (1991) and Hammel and Zamora (1990), mentioned above, concerning the history of present-day forests occupied by *Ticodendron* in Central America. From our studies of Dominican amber fossils, cited earlier, the following genera can be added to this forest type, as represented in the Caribbean region of the late Oligocene or early Miocene: *Roystonea, Trithrinax, Palaeoraphe, Alarista, Pharus, Hymenaea, Licania, Trochanthera, Swietenia, Trichilia, Persea, Treptostemon, Virola, Protium, Distigouania,* and *Ticodendron.*

ACKNOWLEDGMENTS

We thank Alex E. Brown for supplying us with the fossil and the curator of the Missouri Botanical Garden herbarium for providing specimens of *Ticodendron incognitum*. Helpful comments and suggestions from Barry Hammel and a second reviewer are gratefully acknowledged.

REFERENCES

Behnke, H.-D. 1991. Sieve-element characters of *Ticodendron*. Ann. Missouri Bot. Gard. 78:131–134.

Carlquist, S. 1991. Wood and bark anatomy of *Ticodendron*. Ann. Missouri Bot. Gard. 78:96–104.

Chambers, K.L. & G.O. Poinar, Jr. 2010. The Dominican amber fossil *Lasiambix* (Fabaceae: Caesalpinioideae?) is a *Licania* (Chrysobalanaceae). J. Bot. Res. Inst. Texas 4:217–218.

Chambers, K.L., G.O. Poinar, Jr., & A.E. Brown. 2011a. A fossil flower of *Persea* (Lauraceae) in Tertiary Dominican amber. J. Bot. Res. Inst. Texas 5:457–462.

Chambers, K.L., G.O. Poinar, Jr., & A.E. Brown. 2011b. Two fossil flowers of *Trichilia* (Meliaceae) in Dominican amber. J. Bot. Res. Inst. Texas 5:463–468.

Chambers, K.L. & G.O. Poinar, Jr. 2012. A Mid-Tertiary fossil flower of *Swietenia* (Meliaceae) in Dominican amber. J. Bot. Res. Inst. Texas 6:123–127.

Chambers, K.L., G.O. Poinar, Jr., & A.S. Chanderbali. 2012. *Treptostemon* (Lauraceae), a new genus of fossil flower from Mid-Tertiary Dominican amber. J. Bot. Res. Inst. Texas 6:551–556.

Chambers, K.L. & G.O. Poinar, Jr. 2013. A fossil flower of the genus *Protium* (Burseraceae) in Mid-Tertiary amber from the Dominican Republic. J. Bot. Res. Inst. Texas 7:367–373.

Chambers, K.L. & G.O. Poinar, Jr. 2014. *Distigouania irregularis* (Rhamnaceae) gen. et sp. nov. in Mid-Tertiary amber from the Dominican Republic. J. Bot. Res. Inst. Texas 8:551–557.

Draper, G., P. Mann, & J.F. Lewis. 1994. Hispaniola. In: S. Donovan and T.A. Jackson, eds. Caribbean geology: an introduction. The University of the West Indies Publishers' Association, Kingston, Jamaica. Pp. 129–150.

Feuer, S. 1991. Pollen morphology and the systematic relationships of *Ticodendron incognitum.* Ann. Missouri Bot. Gard. 78:143–151.

Gómez-Laurito, J. & L.D. Gómez-P. 1989. *Ticodendron*: a new tree from Central America. Ann. Missouri Bot. Gard. 76:1148–1151.

Gómez-Laurito, J. & L.D. Gómez-P. 1991. Ticodendraceae: a new family of flowering plants. Ann. Missouri Bot. Gard. 78:87–88.

Hammel, B.E. & N.A. Zamora. 1990. *Nyssa talamancana* (Cornaceae), an addition to the remnant Laurasian Tertiary flora of southern Central America. Brittonia 42:165–170.

Hammel, B.E. & W.G. Burger. 1991. Neither oak nor alder, but nearly: the history of Ticodendraceae. Ann. Missouri Bot. Gard. 78:89–95.

Hickey, L.H. & D.W. Taylor. 1991. The leaf architecture of *Ticodendron* and the application of foliar characters in discerning its relationships. Ann. Missouri Bot. Gard. 78:105–130.

Iturralde-Vinent, M.A. & R.D.E. Macphee. 1966. Age and paleogeographic origin of Dominican amber. Science 273: 1850–1852.

Kubitzki, K. 1993. Ticodendraceae. In: K. Kubitzki, J.G. Rohwer, and V. Bittrich, eds. The families and genera of flowering plants. II. Flowering plants—Dicotyledons. Springer-Verlag, Berlin. Pp. 594–596.

Manchester, S.R. 2011. Fruits of Ticodendraceae (Fagales) from the Eocene of Europe and North America. Int. J. Pl. Sci. 172:1179–1187.

Manchester, S.R. & P.R. Crane. 1983. Attached leaves, inflorescence, and fruits of *Fagopsis*, an extinct genus of fagaceous affinity from the Oligocene Florissant flora of Colorado, U.S.A. Amer. J. Bot. 70:1147–1164.

Poinar, G.O., Jr. 1991. *Hymenaea protera* sp. n. (Leguminosae: Caesalpinioideae) from Dominican amber has African affinities. Experientia 47:1075–1082.

Poinar, G.O., Jr. & R. Poinar. 1999. The amber forest. Princeton University Press, Princeton, New Jersey, U.S.A.

Poinar, G.O., Jr. 2002a. Fossil palm flowers in Dominican and Mexican amber. Bot. J. Linn. Soc. 138:57–61.

Poinar, G.O., Jr. 2002b. Fossil palm flowers in Dominican and Baltic amber. Bot. J. Linn. Soc. 139:361–367.

Poinar, G.O., Jr. & E.J. Judziewicz. 2005. *Pharus primuncinatus* (Poaceae: Pharoideae: Phareae) from Dominican amber. Sida 21:2095–2103.

Poinar, G.O. Jr., K.L. Chambers, & A.E. Brown. 2008a. *Lasiambix dominicensis* gen and sp. nov., a eudicot flower in Dominican amber showing affinities with Fabaceae subfamily Caesalpinioideae. J. Bot. Res. Inst. Texas 2:463–471.

Poinar, G.O. Jr., K.L. Chambers, & A.E. Brown. 2008b. *Trochanthera lepidota* gen. and sp. nov., a fossil angiosperm inflorescence in Dominican amber. J. Bot. Res. Inst. Texas 2:1167–1173.

Poinar, G.O. Jr. & J.T. Columbus. 2012. *Alarista succina* gen et sp. nov. (Poaceae: Bambusoideae) in Dominican amber. Histor. Biol. 1–6.

Poinar, G.O. Jr. & R. Steeves. 2013. *Virola dominicana* sp. nov. (Myristicaceae) from Dominican amber. Botany 91:530–534.

Reid, E.M. & M.E.J. Chandler. 1933. The London Clay flora. British Museum (Natural History), London. 561 pp.

Schlee, D. 1999. Das Bernstein-Kabinett. Stuttgarter Beitr. Naturk. Ser. C, 28.

Tobe, H. 1991. Reproductive morphology, anatomy and relationships of *Ticodendron*. Ann. Missouri Bot. Gard. 78: 135–142.

VEGETATION PATTERNS IN THE MEDITERRANEAN-DESERT ECOTONE OF BAJA CALIFORNIA, MEXICO

Sula Elizabeth Vanderplank

Botanical Research Institute of Texas
1700 University Dr.
Fort Worth, Texas 76107 U.S.A.
svanderplank@BRIT.org

Jose Delgadillo

Universidad Autónoma de Baja California
Facultad de Ciencias
Carretera Transpeninsular Ensenada-Tijuana, No. 3917
Fraccionamiento Playitas
Ensenada, Baja California 22860 MÉXICO

Exequiel Ezcurra

University of California, Riverside
Department of Botany and Plant Sciences
900 University Ave.
Riverside, California 92507 U.S.A.

Lucinda A. McDade

Rancho Santa Ana Botanic Garden
and Claremont Graduate University
1500 North College Ave.
Claremont, California 91711 U.S.A.

ABSTRACT

The Pacific coast of NW Baja California is a hotbed of plant species richness and endemism. Greater San Quintín (GSQ), Baja California, Mexico, is located near the southernmost reaches of the California Floristic Province in a vegetation transition zone. Perennial species distributions were recorded and used to assess the distribution and richness of rare, narrowly endemic and native taxa. A Principal Components Analysis assessed the major elements in the perennial flora, and separated the habitats to indicate the primary factors affecting plant distributions. Distribution of plant species is related to elevation and soil type. The data analysis identifies three distinct areas of species richness, each on a different substrate. Three major habitats were resolved in the analysis; however, indicator species provide greater resolution of habitats with similar soils. Range size on a regional scale was not related to local abundance of perennial species. Across the landscape, native, rare and endemic species richness patterns are very similar, suggesting that native plant richness can be used as a proxy for identifying areas rich in sensitive species. This method provides useful data to conservation efforts. Coastal habitat is essential for many species and conservation recommendations for the region are detailed.

RESUMEN

La costa pacífica del noroeste de Baja California es un foco de riqueza y endemismo para numerosas especies vegetales. La región de San Quintín, Baja California, México, se localiza cerca de los límites australes de la Provincia Florística de California, en una zona de vegetación de transición. Se registró la distribución de especies perennes para evaluar la riqueza y distribución de taxa nativos raros y de endemismos restringidos. Un Análisis de Componentes Principales evaluó los elementos primordiales en la flora perenne y separó los hábitats para indicar factores primarios que afectan la distribución de la vegetación. La distribución de las plantas está relacionada con la elevación y el tipo de suelo. El análisis de datos identifica la riqueza de especies vegetales en tres distintas áreas, cada una en un substrato diferente. Se determinaron tres hábitats principales en el análisis; sin embargo, las especies indicadoras aportan mayor resolución de hábitats con suelos similares. El tamaño del rango a escala regional no tuvo relación con la abundancia local de especies perennes. A través del paisaje, los patrones de riqueza de especies nativas, raras y endémicas son muy similares, sugiriendo que la riqueza de flora nativa puede ser utilizada como un agente para identificar áreas ricas en especies sensibles.

Key Words: Endemism, mapping, maritime succulent scrub, rarity, species richness, San Quintín, Baja California, vernal pools

INTRODUCTION

Around the mid-latitudinal belt of the globe, the western side of continents is occupied by deserts while the eastern side is normally covered by forests. This distribution of coastal drylands is driven by the global circulation of oceans: Equator-bound currents on the eastern side of large oceans are deflected westwards by the rotational force of the Earth, to form the equatorial currents and the easterly trade winds. As the westbound surface waters move away from the continents, they pull cold, nutrient-rich waters to the surface that generate a cool, stable coastal atmosphere, with little evaporation from the sea and very low rainfall other than morning fogs. In coasts neighboring these oceanic upwellings, typical coastal fog deserts tend to develop, forming some of the driest ecosystems on earth. Thus, the large-scale circulation of the ocean is the main reason why

coastal deserts are always found on the west side of continents, such as the Succulent Karoo in Africa, Atacama in Chile, the Atlantic Coastal Desert of Morocco, or the deserts of Baja California. All these fog-driven drylands are adjacent to winter-rain Mediterranean ecosystems in higher latitudes, and large coastal Mediterranean-to-desert ecotones driven by fog, more than rains, occupy the transition areas along these coasts (Ezcurra & Mellink 2013).

The over-arching pattern of global species diversity is of increased species numbers and decreased range sizes toward the equator (Rapoport's rule, Stevens 1989). However, regions of very high species diversity and endemism are also found in areas of Mediterranean climate at intermediate latitudes. The California Floristic Province (CFP) has been designated as a global biodiversity hotspot, moreover an area of high endemism that has been heavily impacted by human activity (Myers et al. 2000). The geographic distribution of the California Floristic Province (CFP) essentially coincides with the presence of winter-spring rainfall and the absence of summer precipitation (Minnich & Franco-Vizcaíno 1998; Caso et al. 2007).

At the southern extreme of the CFP, the desert-to-Mediterranean transition in northwestern Baja California has a large proportion (~10%) of endemism, including 172 locally endemic species, many of which are micro-endemic to areas of less than 50 hectares (O'Brien et al., in press). Little is known about the factors controlling the distributions of these narrowly endemic species in these ecotonal drylands.

As we enter a period of accelerated global environmental change, it is predicted that we will see extinctions on an unprecedented scale (Thomas et al. 2004). The CFP is no exception and current estimates are that 66% of endemic species will experience up to 80% range reductions in the next century under even conservative climate change scenarios (Loarie et al. 2008). However, the impacts of climate change have been difficult to assess due to the absence of baseline data from which we can establish distribution patterns and assess the fate of rare and endemic taxa (Jansson 2009).

The southern limit of the CFP has been the subject of debate for decades. Rather than a sharp boundary, there is a gradual Mediterranean-scrub-to-desert transition that begins near the U.S./Mexico border and ends near the 30th parallel near El Rosario according to Shreve (1936). This transitional zone has the greatest floristic diversity in the state of Baja California and transitional vegetation associations recorded here have the highest endemic community values (i.e., greatest densities of narrowly endemic taxa, Peinado et al. 1995a). In the present study we focus on the area between parallels 30 and 31 on the Pacific Coast of Baja California, Mexico, here referred to as 'Greater San Quintín' (GSQ; Fig. 1). Although rainfall is low for most of the year, with an annual average of 105–137 mm (Vanderplank 2011), San Quintín experiences frequent heavy fogs caused by the cool upwelling of the California current off-shore (Herbert et al. 2001), and the associated humidity provides significant extra water resources, to which the local vegetation is adapted (Rundel et al. 1972).

The ecotonal position of San Quintín (where the Mediterranean CFP transitions into the Sonoran desert to the south) often makes species distributions patchy and discontinuous, with the vegetation being very heterogeneous in this region (Vanderplank 2013). Greater San Quintín lies at the southern end of this transitional vegetation and is home to sixty-seven taxa that are endemic or near-endemic to NW Baja California (Vanderplank 2011). The unusual mix of CFP species with plants from the desert area to the south make GSQ a floristically rich area with 433 taxa documented in recent years (Vanderplank 2011). Thirty-four percent of the species that comprise the flora of GSQ are rare and/or locally endemic, making GSQ a priority region for conservation (Vanderplank 2011).

Greater San Quintín is currently under consideration for declaration as a natural protected area or *Área Natural Protegida* (ANP) under Mexican law. Local conservation organizations have identified four distinct terrestrial habitats in need of conservation in GSQ: salt marsh, dunes and beaches, rivers and riparian areas, and the maritime succulent scrub (note that "riparian" areas in this region are most often dry washes with sandy substrates). The habitats have been similarly categorized by the *Instituto Nacional de Estadística Geografía e Informática, México* (INEGI), although upper salt flats are distinguished from inundated marshes.

Conservation efforts are unavoidably biased by available biodiversity data. The challenge of identifying core areas for conservation given the rich assemblage of rare and endemic plants in GSQ is heightened by

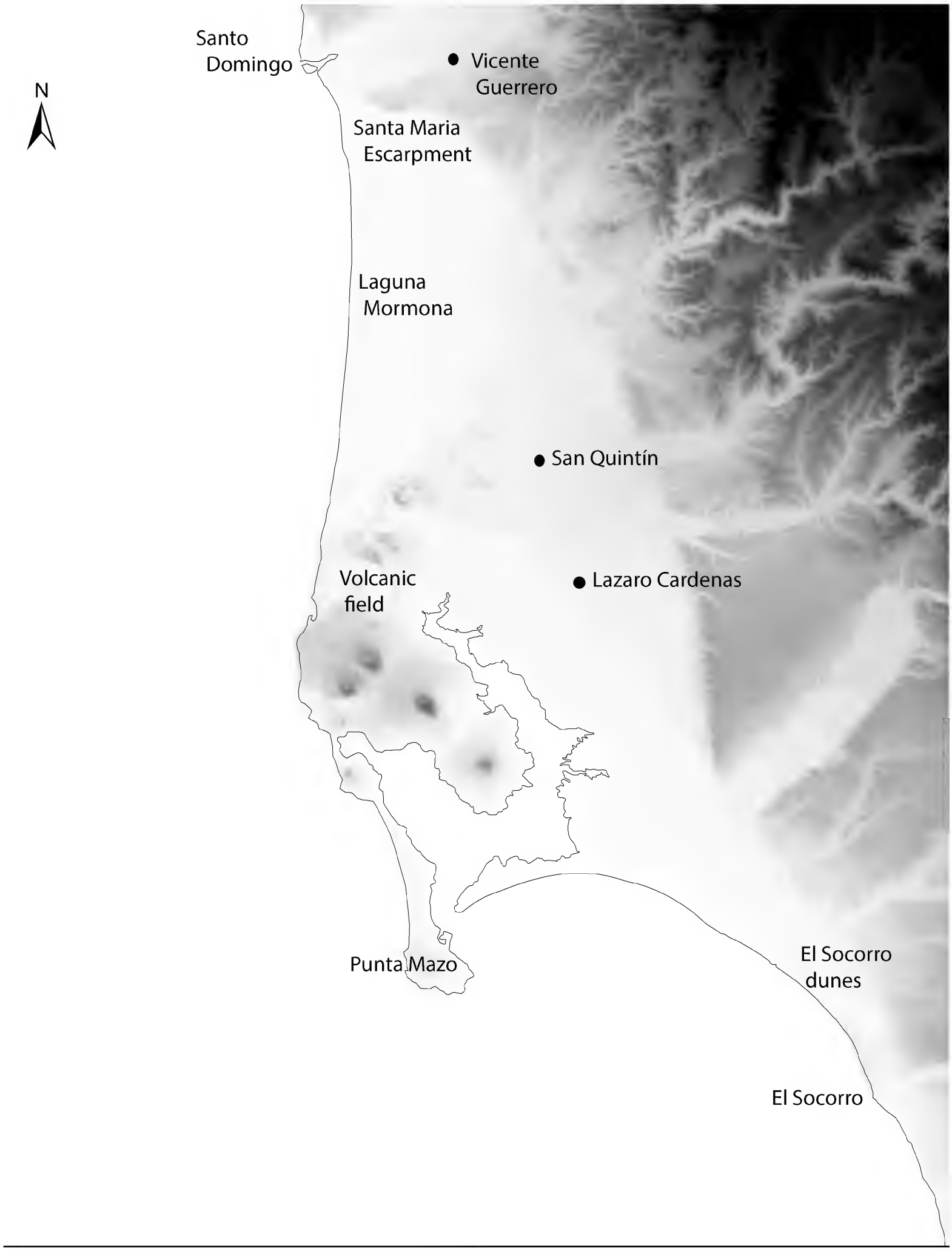


Fig. 1. Topography and local place names within Greater San Quintín. N 30.18–30.45 and W 115.48–116.03.

competition for land use and the heterogeneity of the vegetation itself. Despite the very limited global extent of the maritime succulent scrub (Cartron et al. 2005), the saltmarsh habitat is most frequently the primary conservation target in this region. The saltmarshes of GSQ provide a suite of ecosystem services and provide a model system for restorations in other areas along the Pacific coast (West 2000) yet are the most floristically depauperate habitat, and harbors only one endemic taxon (Bell 2010; Vanderplank 2011).

Fine-scale phytosociological studies in this region have shown diverse shrub associations in northwestern Baja California, where the climate gradient from north to south correlates with increased floristic diversity (both for endemic species and diversity of life-forms) as aridity increases (Peinado et al. 1995a, 1995b). This is the first study conducted at a macroecological scale in this region (1×1 km^2) and brings new perspective on the larger factors controlling vegetation distributions in this region.

A goal of this study was to investigate the distribution of the long-lived taxa that dominate the vegetation and can be identified year-round. This study determines the current status of the terrestrial perennial vegetation and provides baseline data from which future changes in the flora can be assessed and monitored. We here try to assess which factors are dominant in the distribution of vegetation, and in particular, in the distribution of rare and endemic species.

MATERIALS AND METHODS

Sampling methods.—A one-km grid of cells was created in ESRI ArcMap and georeferenced to overlay the study area (the top-left NW corner of the grid lies at N 30.738 and W 116.039). Each grid cell became the macroecological sampling unit for the terrestrial vegetation. TerraSync software was used with a Trimble Juno GPS unit in the field. Grid cells that contained only agricultural fields or urbanized areas, as well as cells with less than 10% cover of natural vegetation were excluded from the analysis.

Quantitative data on presence and abundance of perennial species and selected invasive annual species was gathered within each grid square (the estimation method is described below). All perennial plants that could be identified year-round were included in the analyses; geophytes and herbaceous perennials that could not be consistently identified throughout the year were excluded. Non-native annual taxa that were selected for inclusion were abundant, identifiable year-round, and judged to be potentially invasive. The goal here was to provide spatial information on the current extent of the most abundant non-native species. This study follows the vascular plant checklist for Baja California (Rebman in review) for taxonomy and nativity.

Each square km that had native vegetation was visited to assess a number of traits of the vegetation. A visual assessment was made to estimate the percent natural vegetation and to determine species present. Trials showed that this method encountered a significantly higher number of species than alternative methods (e.g., quadrats or transects) that subsample smaller areas. Several taxa cannot readily be differentiated from one another at all times of the year, these were pooled at a taxonomic level higher than species. For example, the three species of the genus *Lycium* reported from the San Quintín area (these drought-deciduous shrubs cannot easily be distinguished without leaves). Admittedly less than ideal, this approach was preferred over omitting these taxa from the study (see supplemental information table for taxon list).

Abundance per km cell was estimated using the method of Nichols (1930) and the following categories of abundance: (1) rare: fewer than 3 individuals encountered; (2) scarce: 3–10 individuals; (3) uncommon: >10 but < 100 individuals (1/10,000 m^2); (4) frequent: 100–1,000 individuals (1/1,000 m^2); (5) common: 1,000–10,000 individuals (1/100 m^2); (6) abundant: 10,000–100,000 individuals (1/10 m^2); and (7) dominant: >100,000 individuals (1/1 m^2). Estimates were based on number of plants seen and their distribution patterns. When estimating numbers of plants that sprout from roots or rhizomes (e.g., salt grasses such as *Distichlis* spp.), the numbers of individual sprouts were considered, such that these should not be taken to estimate numbers of genetic individuals.

Analysis.—The resulting data matrix for each cell listed perennial and selected non-native annual taxa scored for presence/absence. Perennial species richness was calculated for each square. Pearson's residuals (the standardized difference between the observed species richness in each grid square and the mean over all squares,

Everitt 1992) were calculated. Because Pearson residuals are distributed as normal deviates, those squares that departed significantly ($P < 0.01$) from the mean richness were identified (Everitt 1992) to show areas of significantly high or low richness.

Each taxon was classified according to (1) its origin (native/non-native), (2) endemism (endemic/non-endemic), (3) regional rarity, and (4) local rarity or abundance. All taxa that are restricted to the Baja California peninsula (most of which are also endemic, or nearly so, to the CFP within the peninsula) were classified as endemic. For rarity we followed O'Brien et al. (in press), which is based on previous work by the California Native Plant Society: taxa on any of three lists of concern (i.e., rare globally, rare in CFP Baja California but more common elsewhere, and watch-list taxa) were together categorized as "rare" for our analysis (in the few incidences where multiple taxa were lumped, the category of the most abundant taxon was used). Data on abundance or rarity within Greater San Quintín were drawn from the vegetation data. Species found in more than 40 one-km cells were classified as locally abundant, species found in less than 10 one-km cells were classified as locally scarce, and all species between the two thresholds were classified as intermediate. We tested for association between regional and local rarity, using X^2 contingency-table analysis.

ESRI ArcMap was used to map species distributions across the study area. Data from the matrix were attached to the grid layer using spatial coordinates for each cell. Relevant data layers were obtained from the Instituto Nacional de Estadística y Geografía, México (INEGI 1997, including shore outline, elevation, relief, soil, and habitat types. Following analysis of the data matrix, squares with extreme species richness or paucity (Pearson's residuals, $P < 0.01$) were mapped. The same was done for species richness for three subsets of taxa: native, endemic, and rare species.

Multivariate analysis.—To examine the distribution of species across habitat types as distinguished by The Nature Conservancy of Baja California, a non-standardized principal components analysis (PCA) of the presence-absence matrix for 163 native perennial taxa was conducted. Because the cross-product of two species vectors with presence-absence is simply the number of sites shared by both species, and, reciprocally, the cross-product of two presence-absence site vectors is the number of shared species, PCA on presence-absence data will reflect the number of co-occurrences as a measure of ecological similarity (Ezcurra 1987). The resulting PCA axes were tested for significance using the broken-stick model (Jackson 1993). These scores were then mapped to extract the dominant habitat type for each km square in the analysis. This map was compared to the habitat maps from INEGI and habitat maps generated using indicator species. An indicator species from each of the primary habitats was selected based on observed consistent presence in, and restriction to, specific habitat.

RESULTS

Vegetation patterns.—The analysis of vegetation tallied a total of 163 taxa, including 140 native perennials, across the 206 one-km cells (Table 1). This analysis allowed individual taxa to be mapped across the study area and their abundance displayed for each km square. The abundance distribution of endemic and rare species did not differ significantly from that of the total native flora within the Greater San Quintín area ($X^2 = 1.86$; df = 2, $P = 0.39$; Table 1), indicating that plants that are rare at a regional scale may be locally abundant within our study site, and, conversely, that plants that are regionally common may be locally scarce within our site.

Total species richness within each one-km cell varies across the study region (Fig. 2). The spatial distribution of significantly ($P > 0.01$) high and low Pearson's residuals for the whole flora shows some well-defined patterns (Fig 3a), especially for high-diversity cells, that tend to occur in three distinct spatial clusters. These spatial patterns of high richness are repeated in a similar manner for subsets of the flora (total native, Fig. 3b; endemic, Fig. 3c; rare taxa, Fig. 3d).

Species richness is low adjacent to agriculture and urbanized areas (compare Fig. 3 to Fig. 5b). Richness in the salt marshes and saline flats is much lower than in other habitats. This is particularly evident north of the volcanic field and south of the Santa María Escarpment in the area surrounding Laguna Mormona (note bands of pale yellow squares along the coast; Fig. 3a & b). Non-native taxa are especially rich in riparian areas,

Table 1. Native species total (140 species) and parsed into two categories of regional rarity within the CFP in Baja California (endemism and rarity), and by their local abundance category based on their frequency within Greater San Quintín (scarce, intermediate, or abundant).

Local Rarity	Endemic	Rare	Total native
Scarce	12	16	67
Intermediate	12	16	47
Abundant	5	8	26
Totals	29	40	140

and their distributions follow all major drainages. The non-native iceplant *Mesembryanthemum crystallinum* occurs almost ubiquitously across the study area. It is interesting to note that there was no correlation between percent natural vegetation in a square and species richness ($r = 0.11$, df = 196; $P = 0.13$). This absence of a clear species-area relationship at the one-km cell scale is most likely due to heterogeneity of the landscape; three habitat types coexist in a fraction of a one-km cell in whereas in others an entire km cell of degraded salt marsh that might have only four perennial species.

Areas of high species richness.—Three primary regions of high species richness emerge from the vegetation study: at the northern and southern extremes of the study area and along the coast adjacent to the volcanic field.

Northern biodiversity hotspot: The northern region of high species richness has two distinct subareas: Santo Domingo wash (northern boundary of the study area) and a clay mesa (slightly southeast from the wash). The Santo Domingo wash shows high species richness when all taxa are considered (Fig. 3a); however, richness here decreases somewhat when non-native taxa are excluded (Fig. 3b), and the area has few rare (Fig. 3d) or endemic (Fig. 3c) species. In contrast, the clay mesa in Colonia Vicente Guerrero, north of the Santa Maria escarpment, presents a strong signal of high species richness for native, endemic, and rare species (i.e., compare Figs. 3a–d). This area is a disturbed patch of vegetation with diverse succulent scrub and some small remnant-but-degraded vernal pools. Like the Santo Domingo wash this area has significantly more non-native species than typical of the study area as a whole.

Volcanic coast hotspot: The coastal strip near the volcanic field that includes the tip of the sandy peninsula at Monte Mazo is particularly diverse. This area includes a complex patchwork of habitats along the coast which likely contributes to high species richness. The precise cells that show significant richness among the analyses vary slightly (i.e., compare Figs. 3a–d), but the coastal strip is always rich in native, rare, and endemic species. There are not significantly high numbers of non-natives in this area (consistent with the relatively intact nature of the habitats).

Southern dunes hotspot: Near the southern end of the study area, the El Socorro Dunes stand out as the largest area of high species richness. Because only one habitat type is represented across several cells here, the observed high richness is not the result of habitat heterogeneity. Although there are some differences in the pattern of cells that harbor significantly high numbers of native, endemic, and rare taxa, the area is rich in all of these.

Multivariate analysis.—The Principal Components Analysis showed two axes that, according to the broken stick test, departed significantly from a random model (Fig. 4). The first axis is positively correlated with topographic elevation ($r = 0.41$, df = 204, $P < 0.0001$) and displays a salinity-elevation gradient: plants of coastal habitats are on the left and those of maritime succulent scrub are on the right (positive on axis 1). The second axis reflects soil type on coastal habitats and separates saltmarshes (positive on axis 2) from freshwater and sand dune species (negative on axis 2). The corresponding species plot, accordingly, shows three distinct clusters of species dominating in three habitat types: (a) scrub, (b) saltmarshes, and (c) sandy soil plants regardless of whether on dunes or in riparian areas (Fig. 4.). When mapped back onto the study area, the three habitats identified by the PCA bi-plots produced a map that was very consistent with the vegetation chart (INEGI 1997 produced with completely different methods (Fig. 5).

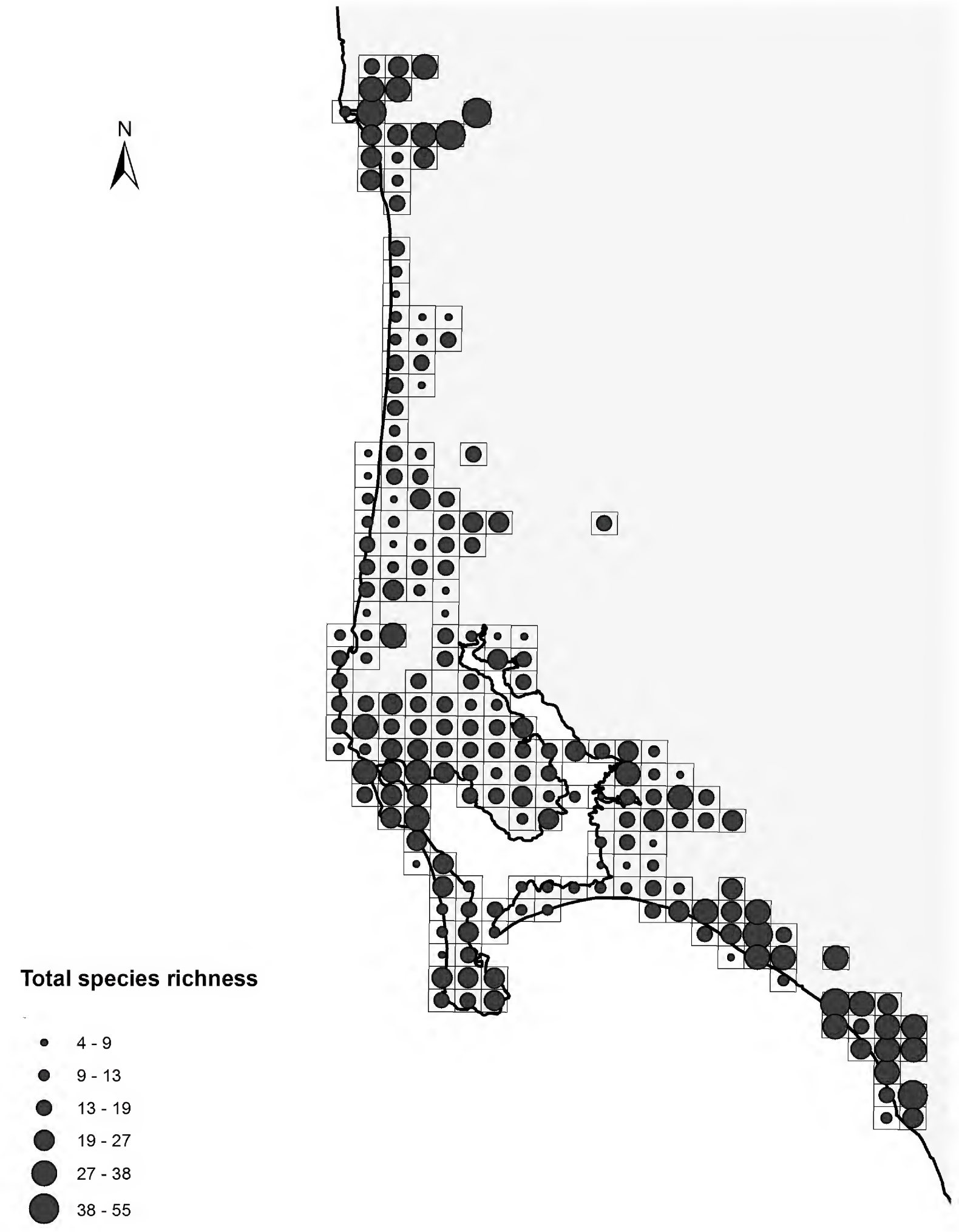


FIG. 2. Total species richness in 206 one-km cells for perennial vegetation of Greater San Quintín. As indicated at lower left, the size of the circle reflects number of species recorded in each cell.

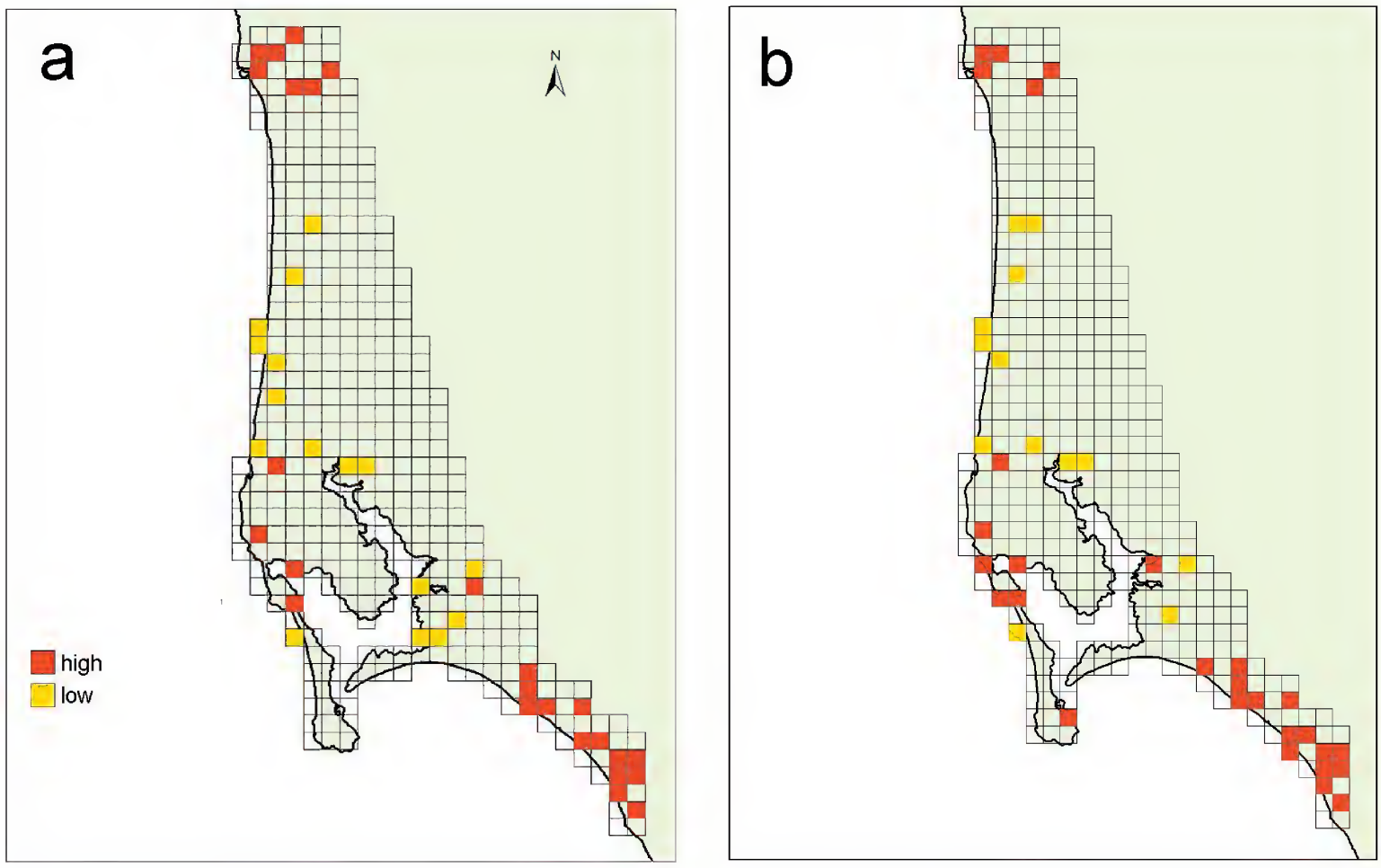


Fig. 3. Spatial pattern of 206 cells with significantly higher (red) and lower (yellow) species richness than expected using Pearson's residuals ($P < 0.01$) to test departure from random distributions for (a) all species; (b) native species; (c) endemic species; (d) rare species.

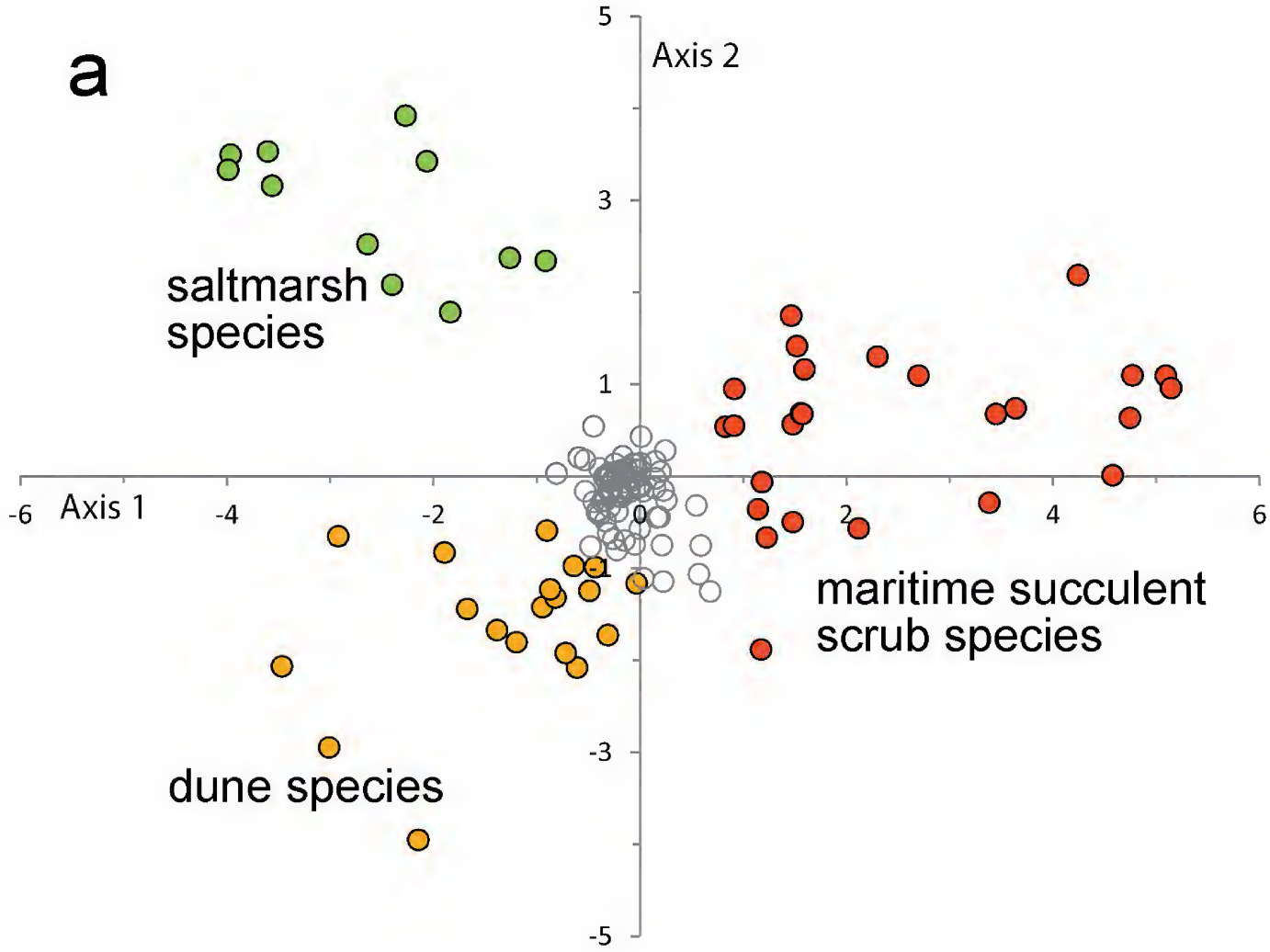


Fig. 4. First two axes of PCA biplot for (a) species and (b) one km cells. Axis 1 separates maritime succulent scrub species and sites (red) which occur in the higher parts of the area, from the more coastal vegetation types. Axis 2 separates saltmarsh species and sites (green) from dune species (orange) and sandy soil communities (yellow).

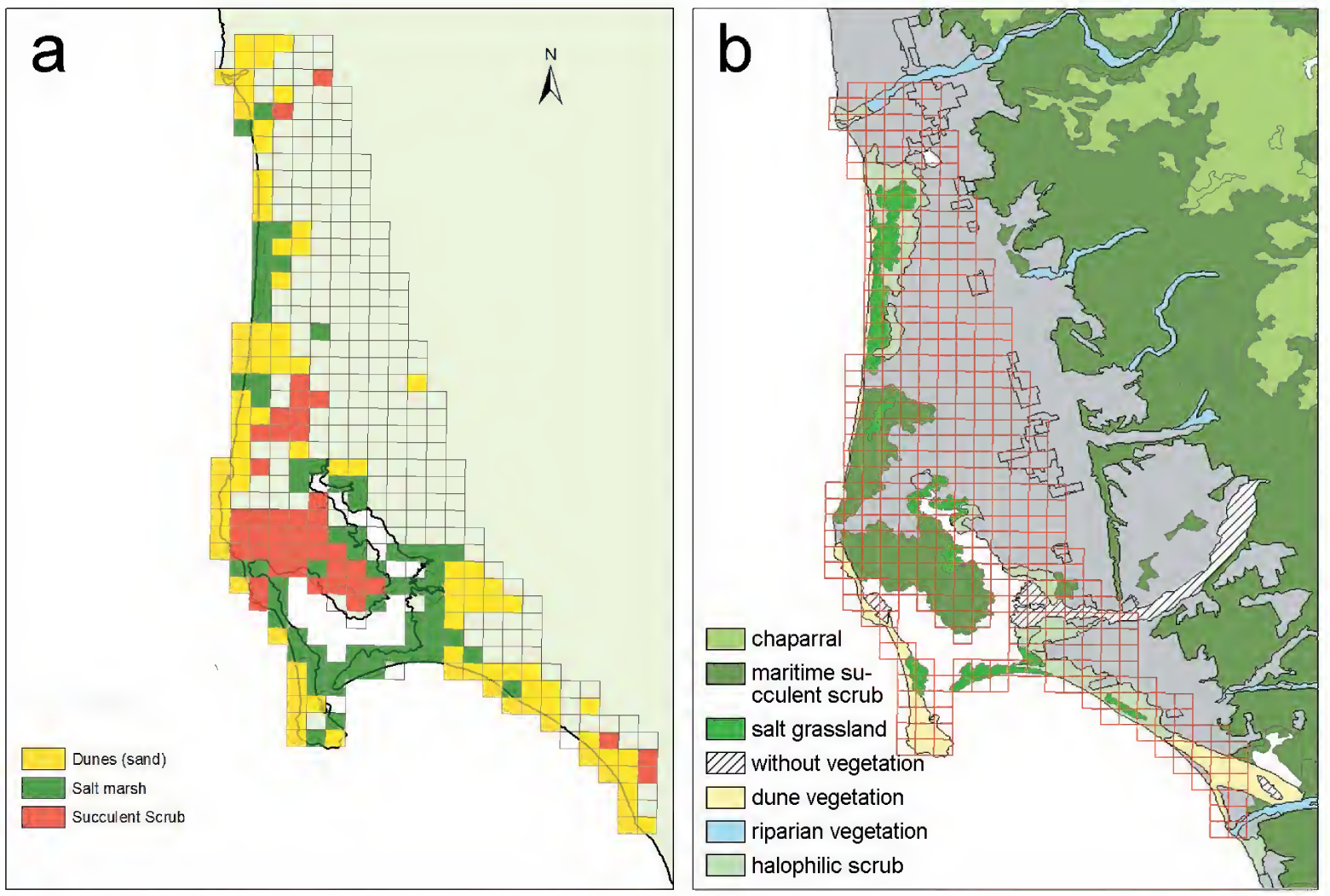


Fig. 5. (a) Spatial pattern of habitats defined by the first two PCA axes (see Fig. 4). (b) Vegetation map of Greater San Quintín (GSQ) modified from Geographic Information System layers provided by INEGI (gray indicates areas without vegetation).

DISCUSSION

Patterns in the perennial vegetation

The analysis of perennial vegetation clearly identified overlapping areas of high species richness for the analysis of the regional endemic flora and for native plants as a whole. This suggests that endemics are distributed across GSQ in the same pattern as native species, and as a result, species rich areas will have many range-restricted taxa. On the other hand, local rarity was found to be independent of regional rarity—taxa that are rare at the regional scale are equally likely to be rare or abundant at the local scale—suggesting that many regional endemics may be abundant where found, a result of importance for conservation.

The multivariate analysis identified groups of species whose distribution can be readily interpreted as related to elevation and soil type. This suggests that these two variables are key factors in species distributions. Many species are in the central cluster with variation in their distributions unexplained by these axes. Some are generalist species that do not have marked habitat preference and whose occurrence is not highly associated to the presence of other species. Additionally, because the sampling regime (i.e., one-km^2 cells) does not necessarily correspond exactly with habitats (i.e., several habitats may fall within any given cell), many taxa that occupy different habitats may be co-mingled in the data matrix, in effect limiting the discriminatory power of the analysis.

More attention should be paid to both the geologic origins and soil types of the region and the extent of the salt spray zone. It is likely that these factors affect plant distributions throughout GSQ. The vegetation of the region can be seen to clearly differ among sand, mud, volcanic rock, or clay substrates. As a direct result of this, carefully selected indicator species can give finer scale resolution of habitats (Fig. 6). Many species are restricted to entirely coastal habitats (e.g., dunes), highlighting the importance of coastal ecosystems to biodiversity conservation.

Regions of high perennial species richness

Coastal volcanic field: The coastal strip along the volcanic field of San Quintín includes many species that should be a high priority for conservation in Mexico due to their limited distribution. The unique geology of the volcanic field is connected to a number of edaphically restricted endemic species (Vanderplank 2011]); this area should be prioritized in regional conservation efforts. Conservation of the maritime succulent scrub that occurs on clay soils outside the volcanic field will require more regional analysis beyond the boundaries of GSQ where this habitat occurs in larger intact areas.

El Socorro Dunes: The El Socorro Dunes represent an unusually large and intact dune system that should be highly prioritized for protection. It is perhaps the area most in need of conservation. The unusual composition and high species diversity found here are not matched elsewhere in Mexico (Rodríguez-Revelo et al. 2014). There is a wealth of archeological data from the area in the form of coastal shell middens and shards (Moore 1999) that also provides significant justification for conservation of this region. In December 2010, the entire dune system was slated for development and was being divided into narrow strips that connect the main road to the beach.

Clay mesa of Vicente Guerrero: The clay mesa just north of the Santa María Escarpment, in Colonia Vicente Guerrero, is used as a village commons by the local *ejidatarios*. The area is often used as a latrine and as a trash dump. Restoration of the vernal pools here may be feasible but would require protection and monitoring. Although small in size, the vernal areas here could serve as a re-introduction site for species extirpated elsewhere in Greater San Quintín. This area may be ideal for a community outreach and education project encompassing habitat restoration.

CONCLUSIONS

Patterns in the flora are strongly related to elevation or distance from the sea, and soil conditions. On a broad scale these parameters characterize four broad habitat types, yet on a finer scale, specialized micro-habitats with range-restricted taxa are also present. Native species richness is the primary indicator for rare and endemic species richness in the flora. Conservation of biodiversity here will conserve the majority of endangered taxa; however specific measures (e.g., protection of key areas) are necessary to conserve micro-endemics and the endemics of micro-habitats.

The perennial flora of the area forms a rich heterogeneous matrix, with high levels of endemism and rare plant species throughout. As a transitional area in a global biodiversity hotspot, the heterogeneity of GSQ may provide critical refugia for many species under a changing climate regime. Ongoing assessment of habitat quality and the status of the globally rare and locally endemic taxa in this region are strongly recommended.

The results presented here provide valuable data for planning in this region and may be used to model faunal distributions for taxa that exhibit species-specific and habitat-specific interactions. This methodology is recommended for future floristic studies seeking to provide baseline data to conservation.

APPENDIX 1

Table of perennial and selected non-native species from Greater San Quintín. Their status (non-native, rare, endemic) is given as assessed for each taxon in the study (rarity and endemism follows combined values from B. O'Brien et al. (In Press, taxonomy and nativity follow Rebman (In Review).

Family	Taxon	Non-native	Rare	Endemic
Agavaceae	*Agave shawii* subsp. *shawii*		X	X
Agavaceae	*Yucca schidigera*			
Aizoaceae	*Carpobrotus chilensis*	X		
Aizoaceae	*Mesembryanthemum crystallinum*	X		
Aizoaceae	*Mesembryanthemum nodiflorum*	X		
Anacardiaceae	*Malosma laurina*			
Anacardiaceae	*Rhus integrifolia*			
Anacardiaceae	*Toxicodendron diversilobum*			
Apiaceae	*Foeniculum vulgare*	X		
Apocynaceae	*Asclepias subulata*			

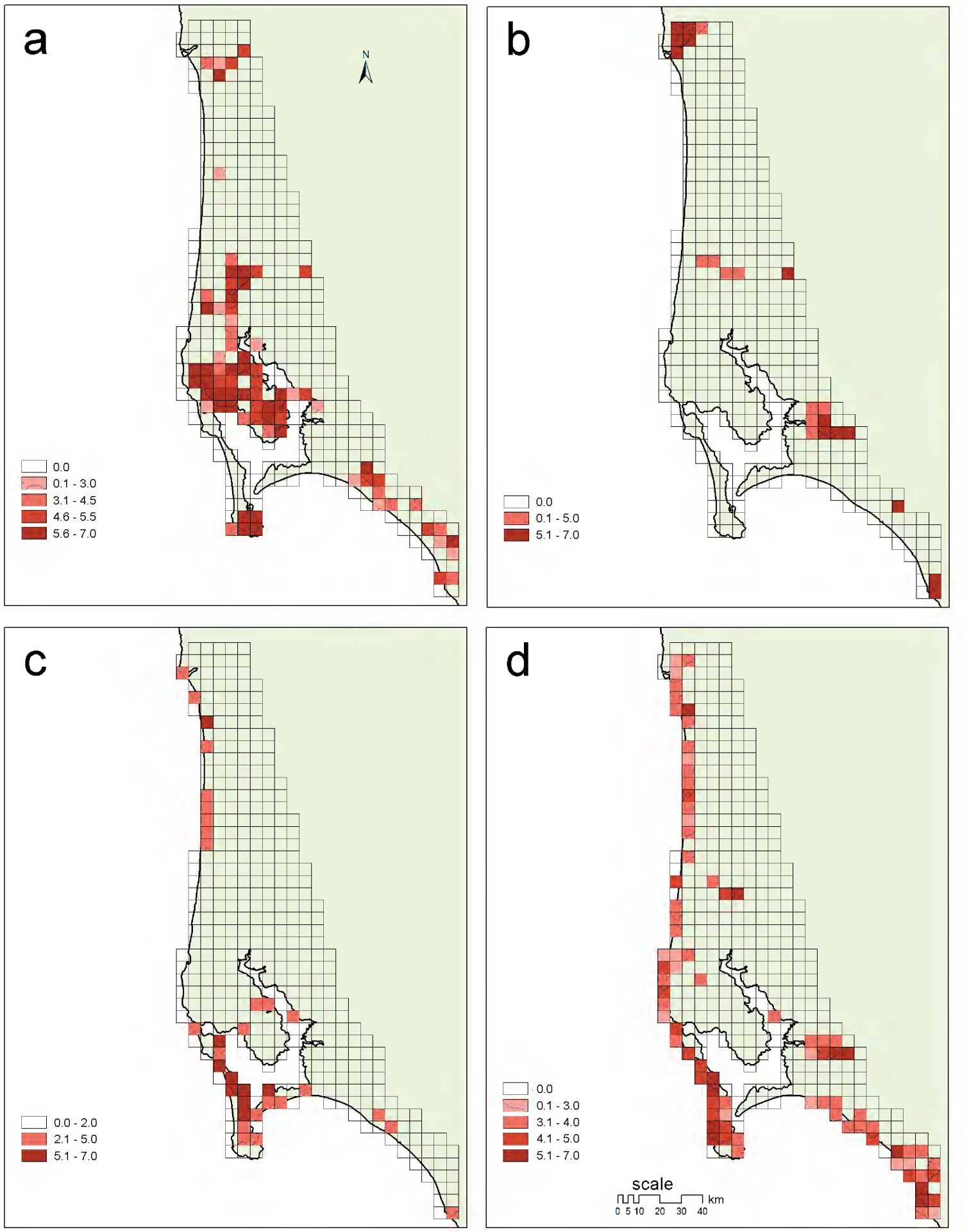


Fig. 6. Distribution and abundance of the main indicator species (compare to habitats in Fig. 5). Intensity of color reflects number of individuals per km^2. (a) *Ambrosia chenopodiifolia*, an indicator for maritime succulent scrub; (b) *Ambrosia monogyra*, indicator for riparian habitat; (c) *Jaumea carnosa*, indicator for saltmarsh habitat; (d) *Helianthus niveus*, indicator for dunes and other sandy soils (note that some plants also occur in sandy riparian areas near the coast).

APPENDIX 1
(continued)

Family	Taxon	Non-native	Rare	Endemic
Apocynaceae	*Funastrum arenarium*			
Asteraceae	*Ambrosia chamissonis*		X	
Asteraceae	*Ambrosia chenopodifolia*			
Asteraceae	*Ambrosia confertiflora*			
Asteraceae	*Ambrosia monogyra*			
Asteraceae	*Artemisia californica*			
Asteraceae	*Artemisia dracunculus*			
Asteraceae	*Artemisia dracunculus*			
Asteraceae	*Artemisia tridentata*			
Asteraceae	*Baccharis pilularis*			
Asteraceae	*Baccharis salicifolia*			
Asteraceae	*Baccharis sarothroides*			
Asteraceae	*Bahiopsis laciniata*			
Asteraceae	*Bahiopsis triangularis*			
Asteraceae	*Bebbia juncea*			
Asteraceae	*Brickellia californica*			
Asteraceae	*Centauria melitensis*	X		
Asteraceae	*Chrysanthemum coronarium*	X		
Asteraceae	*Leptosyne maritima*		X	X
Asteraceae	*Encelia asperifolia*		X	
Asteraceae	*Encelia californica*			
Asteraceae	*Encelia farinosa*			
Asteraceae	*Ericameria palmeri*		X	X
Asteraceae	*Eriophyllum confertiflorum*			
Asteraceae	*Hazardia berberidis*		X	X
Asteraceae	*Helianthus niveus*		X	X
Asteraceae	*Heterotheca grandiflora*			
Asteraceae	*Isocoma menziesii* subsp. *menziesii*			
Asteraceae	*Isocoma menzeisii* subsp. *decumbens*		X	X
Asteraceae	*Iva haesiana*			
Asteraceae	*Jaumea carnosa*		X	
Asteraceae	*Pluchea sericea*			
Asteraceae	*Pseudognaphalium biolettii, P. leucocephalum*			
Asteraceae	*Senecio lyonii*		X	
Asteraceae	*Stephanomeria exigua, S. diegensis*			
Asteraceae	*Trixis californica*			
Bataceae	*Batis maritima*			
Brassicaceae	*Brassica nigra*	X		
Brassicaceae	*Brassica tournfordii*	X		
Brassicaceae	*Dithyrea maritima*		X	
Brassicaceae	*Sisymbrium irio*	X		
Cactaceae	*Bergerocactus emoryi*		X	X
Cactaceae	*Cylindropuntia alcahes*			
Cactaceae	*Cylindropuntia californica* subsp. *rosarica*		X	X
Cactaceae	*Cylindropuntia cholla*			X
Cactaceae	*Cylindropuntia molesta*			X
Cactaceae	*Cylindropuntia prolifera*			
Cactaceae	*Echinocereus maritimus*		X	X
Cactaceae	*Ferocactus fordii*		X	X
Cactaceae	*Lophocereus schottii*			
Cactaceae	*Mammillaria brandegeei*		X	X
Cactaceae	*Mammillaria dioica, M. louisae*		X	
Cactaceae	*Myrtillocactus cochal*			
Cactaceae	*Opuntia littoralis, Opuntia oricola, O. phaeacantha*			
Cactaceae	*Stenocereus gummosus*			
Cleomaceae	*Peritoma arborea*			
Caryophyllaceae	*Cardionema ramossissima*			
Chenopodiaceae	*Allenrollfea occidentalis*			

APPENDIX 1
(continued)

Family	Taxon	Non-native	Rare	Endemic
Chenopodiaceae	*Arthrocnemum subterminale*			
Chenopodiaceae	*Atriplex canescens*			
Chenopodiaceae	*Atriplex julacea*			
Chenopodiaceae	*Atriplex leucophylla*			
Chenopodiaceae	*Atriplex semibaccata, A. suberecta*	X		
Chenopodiaceae	*Atriplex watsonii*			
Chenopodiaceae	*Chenopodium murale*	X		
Chenopodiaceae	*Salsola tragus*	X		
Chenopodiaceae	*Salicornia pacifica*			
Chenopodiaceae	*Suaeda* spp. (*S. esteroa, S. nigra, S. taxifolia*)			
Crassulaceae	*Dudleya anthonyi*		X	X
Crassulaceae	*Dudleya attenuata*			
Crassulaceae	*Dudleya cultrata*		X	X
Cyperaceae	*Cyperus esculentus*			
Cyperaceae	*Bolboschoenus maritimus*			
Ephedraceae	*Ephedra californica*			
Equisetaceae	*Equisetum laevigatum*			
Ericaceae	*Arctostaphylos glauca*			
Euphorbiaceae	*Acalypha californica*			
Euphorbiaceae	*Croton californicus*			
Euphorbiaceae	*Euphorbia misera*			
Euphorbiaceae	*Riccinus communis*	X		
Euphorbiaceae	*Stillingia linearifolia*			
Fabaceae	*Astragalus anemophilus*			
Fabaceae	*Astragalus fastidius, A. gruinus, A. trichopodus*			
Fabaceae	*Acmispon niveus*		X	X
Fabaceae	*Acmispon distichum*		X	X
Fabaceae	*Acmispon heermanii*		X	
Fabaceae	*Acmispon watsonii*		X	X
Fabaceae	*Lupinus* cf. *longifolius*			
Fabaceae	*Prosopis glandulosa*			
Frankeniaceae	*Frankenia palmeri*		X	
Frankeniaceae	*Frankenia salina*			
Geraniaceae	*Erodium* spp.	X		
Grossulariaceae	*Ribes tortuosum*		X	X
Hippocastanaceae	*Aesculus parryi*		X	X
Boraginaceae	*Eriodictyon angustifolium*			
Boraginaceae	*Eriodictyon sessilifolium*		X	X
Boraginaceae	*Phacelia ixoides*		X	X
Juncaceae	*Juncus acutus* subsp. *leopoldii*			
Juncaceae	*Juncus mexicanus*			
Juncaginaceae	*Triglochin maritina*		X	
Lamiaceae	*Hyptis emoryi*			
Lamiaceae	*Salvia apiana*			
Lamiaceae	*Salvia brandegeei*		X	X
Loasaceae	*Petalonyx linearis*			
Malvaceae	*Malacothamnus fasciculatus*			
Malvaceae	*Malva parviflora*	X		
Malvaceae	*Sphaeralcea ambigua*			
Malvaceae	*Sphaeralcea fulva, S. axillaris*		X	X
Ncytaginaceae	*Mirabilis laevis* var. *laevis*		X	
Nyctaginaceae	*Abronia maritima*		X	
Onagraceae	*Camissonia cheiranthifolia*			
Onagraceae	*Camissonia crassifolia*		X	X
Papaveraceae	*Argemone munita*			
Phrymaceae	*Mimulus puniceus*			
Plantaginaceae	*Gambelia juncea*			
Plantaginaceae	*Penstemon spectabilis* subsp. *subinteger*		X	X

APPENDIX 1
(continued)

Family	Taxon	Non-native	Rare	Endemic
Platanaceae	*Platanus racemosa*			
Plumbaginaceae	*Limonium californicum*		X	
Poaceae	*Arundo donax*	X		
Poaceae	*Bromus madritensis*	X		
Poaceae	*Cynodon dactylon*	X		
Poaceae	*Distichlis littoralis*			
Poaceae	*Distichlis spicata*			
Poaceae	*Melica imperfecta, M. frutescens*			
Poaceae	*Pennisetum ciliare*	X		
Poaceae	*Phalaris minor*	X		
Poaceae	*Schismus barbata*	X		
Poaceae	*Spartina foliosa*		X	
Poaceae	*Stipa lepida*			
Polygonaceae	*Eriogonum fasciculatum*			
Polygonaceae	*Harfordia macroptera* subsp. *galioides*		X	X
Polygonaceae	*Polygonum aviculare, P. agyroceolum*	X		
Polygonaceae	*Rumex pulcher*			
Polypodiaceae	*Cheilanthes/Pentogramma/Aspidotis*			
Polypodiaceae	*Pellaea mucronata*			
Polypodiaceae	*Polypodium californicum*			
Ranunculaceae	*Clematis pauciflora*			
Rhamnaceae	*Ceanothus leucodermis*			
Rhamnaceae	*Rhamnus crocea*			
Rosaceae	*Adenostoma fasciculatum*			
Rosaceae	*Heteromeles arbutifolia*			
Rosaceae	*Rosa minutifolia*		X	X
Salicaceae	*Salix exigua* var. *hindsiana*		X	
Salicaceae	*Salix lasiolepis*			
Saururaceae	*Anemopsis californica*			
Simmondsiaceae	*Simmondsia chinensis*			
Solanaceae	*Lycium* spp. (*L. brevipes, L. californicum, L. andersonii, L. fremontii*)			
Solanaceae	*Nicotiana glauca*	X		
Solanaceae	*Solanum americanum*			
Solanaceae	*Solanum hindsiana*			
Solanaceae	*Solanum palmeri*		X	X
Tamaricaceae	*Tamarix ramosissima*	X		
Typhaceae	Typha dominguensis			

ACKNOWLEDGMENTS

Funding was generously provided by The Jiji Foundation, Rancho Santa Ana Botanic Garden, and Claremont Graduate University, Claremont University Club, BJ Ledyard, Tony LaFetra, and the California Native Plant Society. We thank the staff of the RSA-POM, BCMEX, and SD herbaria for their assistance with herbarium specimens. Thanks to Giandiego Campetella, Laco Mucina, Phil Rundel, and an anonymous reviewer for their helpful edits and suggestions. Many people helped with field work. Vanderplank is especially grateful to Jorge Ochoa and Sergio Mata for their field assistance and to Naomi Fraga and Richard Felger for their insightful comments and long-term mentoring. For institutional support Vanderplank thanks UCMEXUS (The University of California Institute for Mexico and the United States); Rancho Santa Ana Botanic Garden; San Diego Natural History Museum; Terra Peninsular A.C.; and the Next Generation of Sonoran Desert Researchers.

REFERENCES

Bell, H.L. 2010. A new species of *Distichlis* (Poaceae, Chloridoideae) from Baja California, Mexico. Madroño 57(1):54–63.

Brooks, T.M., R.A. Mittermeier, C.G. Mittermeier, G.A.B. da Fonseca, A.B. Rylands, W.R. Konstant, P. Flick, J. Pilgrim, S. Oldfield,

G. Magin, & C. Hilton-Taylor. 2002. Habitat loss and extinction in the hotspots of biodiversity. Conservation Biol. 16:909–923.

Cartron, J.E., G. Ceballos, & R.S. Felger, eds. 2005. Biodiversity, ecosystems and conservation in Northern Mexico. Oxford University Press, New York, U.S.A.

Caso, M., C. González-Abraham, & E. Ezcurra. 2007. Divergent ecological effects of oceanographic anomalies on terrestrial ecosystems of the Mexican Pacific coast. Proc. Natl. Acad. Sci.104:10530–10535.

Everitt, B.S. 1992. The analysis of contingency tables, 2nd edition. Monographs on statistics & applied probability. Chapman & Hall/CRC Press, Boca Raton, Florida, U.S.A.

Ezcurra, E. 1987. A comparison of reciprocal averaging and non-centered principal component analysis. Vegetatio 71:41–48.

Ezcurra E. & E. Mellink. 2013. Desert Ecosystems. In: S.A. Levin, ed. Encyclopedia of Biodiversity, second edition. Academic Press, Waltham, MA, U.S.A. 2:457–478

Fuller, T., V. Sánchez-Cordero, P. Illoldi-Rangel, M. Linaje, & S. Sarkar. 2007. The cost of postponing biodiversity conservation in Mexico. Biol. Conservation 134:593–600.

Herbert, T.D., J.D. Schuffert, D. andreasen, L. Heusser, M. Lyle, A. Mix, A.C. Ravelo, L.D. Stott, & J.C. Herguera. 2001. Collapse of the California Current during glacial maxima linked to climate change on land. Science 293:71–76.

Instituto Nacional de Geografía Estadística e Informática (INEGI). 1997. Mapa digital de uso del suelo y vegetación de Baja California y Baja California Sur (Serie 2), escala 1:250, 000.

Jackson, D.A. 1993. Stopping rules in principal components analysis: A comparison of heuristical and statistical approaches. Ecology 74:2204–2214

Jansson, R. 2009. Extinction risks from climate change: Macroecological and historical insights. Biol. Rep. 1:44.

Kramer, G.W. 1983. Some birds of Bahia de San Quintín, Baja California. American Birds. Pp. 270–272.

Loarie, S.R., B.E. Carter, K. Hayhoe, S. McMahon, R. Moe, C.A. Knight, & D.D. Ackerly. 2008. Climate change and the future of California's endemic flora. PLoS ONE 3(6):1–10.

Luhr, J.F., J.J. Aranda-Gómez, & T.B. Housh. 1995. San Quintín Volcanic Field, Baja California Norte, México: Geology, petrology, and geochemistry. J. Geophys. Res. 100:10353–10380.

Minnich, R.A. & E. Franco-Vizcaíno. 1998. Land of chamise and pines: Historical descriptions of vegetation in northern Baja California. Univ. Calif. Publ. Bot. 80:1–166.

Moore, J.D. 1999. Archaeology in the forgotten peninsula: Prehistoric settlement and subsistence strategies in Northern Baja California. J. Calif. Great Basin Anthropol. 21:17–44.

Myers, N., R.A. Mittermeier, C.G. Mittermeier, G.A.B. da-Fonseca, & J. Kent. 2000. Biodiversity hotspots for conservation priorities. Nature 403:853–858.

Nichols, G.E. 1930. Methods in the floristic study of vegetation. Ecology 11:127–135.

O'Brien, B., J. Delgadillo-Rodríquez, S.A. Junak, T.A. Oberbauer, J.P. Rebman, H. Riemann, & S.E. Vanderplank. In Press. The rare, endangered and endemic plants of the California Floristic Province portion of Baja California, Mexico. Aliso Occas. Publ. Accepted Nov 2013.

Peinado, M., F. Alcaraz, J. Delgadillo, & I. Aguado. 1994. Fitogeografía de la peninsula de Baja California, México. Anales Jard. Bot. Madrid 51(2):255–277.

Peinado, M., F. Alcaraz, J.L. Aguirre, J. Delgadillo, & I. Aguado. 1995a. Shrubland formations and associations in Mediterranean-desert transitional zones of northwestern Baja California. Vegetatio 117:165–179.

Peinado, M., F. Alcaraz, J.L. Aguirre, & J. Delgadillo. 1995b. Major plant communities of warm North American deserts. J. Veg. Sci. 6:79–94.

Raven, P.H. & D.I. Axelrod. 1978. Origin and relationships of the California flora. Univ. Calif. Publ. Bot. 72:1–134.

Rebman, J.P. In Prep. Checklist of the vascular plant checklist for Baja California. Proc. San Diego Soc. Nat. Hist. (Expected 2014).

Riemann, H. & E. Ezcurra. 2005. Plant endemism and natural protected areas in the peninsula of Baja California, Mexico. Biol. Conservation 122:141–150.

Riemann, H. & E. Ezcurra. 2007. Endemic regions of the vascular flora of the peninsula of Baja California, Mexico. J. Veg. Sci. 18:327–336.

Rodríguez-Revelo, N., G. Rendón Márquez, I. Espejel, O. Jiménez Orocio, & M. L. Martínez Vázquez. 2014. Análisis de procedencia de las arenas del complejo de dunas parabólicas El Socorro, Baja California, México, mediante una caracterización mineralógica y granulométrica. Bol. Soc. Geol. Mexico 66(2): Published online: May 16th, 2014.

Rundel, P.W., P.A. Bowler, & T.W. Mulroy. 1972. A fog-induced lichen community in Northwestern Baja California, with two new species of *Desmazieria*. Byrologist 75:501–508.

Rundel, P.W. 2007. Sage scrub. In: M.G. Barbour, T. Keeler-Wolf, & A.A. Schoenerr, eds. Terrestrial vegetation of California. 3rd edition. University of California Press, Berkeley, California, U.S.A. Pp. 208–228.

Shreve, F. 1936. The transition from desert to chaparral in Baja California. Madroño 3:257–264.

Soto, H.J.A. 1987. Identificación taxonómica de malezas en cultivo de tomate (*Lycopersicum esculentum* Mill.) en la región de San Quintín, B.C. Tesis de Licenciatura, Esculela Superior de Ciencias, Universidad Autónoma de Baja California, Ensenada, B.C., México.

Stevens, G.C. 1989. The latitudinal gradients in geographical range: How so many species co-exist in the tropics. Amer. Naturalist 133:240–256

Thomas, C.D., A. Cameron, R.E. Green, M. Bakkenes, L.J. Beaumont, Y.C. Collingham, & S.E. Williams. 2004. Extinction risk from climate change. Nature 427:45–148.

Vanderplank, S.E. 2011. The flora of Greater San Quintín, Baja California, Mexico (2005–2010). Aliso 29:65–106

Vanderplank, S. 2013. Endemism in an ecotone: From Chaparral to Desert in Baja California, Mexico. In: C. Hobhom, ed. Endemism in vascular plants. Springer-Verlag, Gmbh, Germany. Pp. 205–218.

West, J.M. 2000. San Quintín Bay. In: J.B. Zedler, ed. Handbook for restoring tidal wetlands. CRC Press, Boca Raton, Florida, U.S.A. Pp. 36–37.

Wiggins, I. 1980. The flora of Baja California. Stanford University Press, Stanford, California, U.S.A.

BOOK REVIEW

Ricky J. Linex. 2014. **Range Plants of North Central Texas—A Land User's Guide to Their Identification, Value and Management.** (ISBN-13: 978-1-4951-2165-4, pbk., spiral-bound). USDA Natural Resources Conservation Service, 532 Santa Fe Drive, Weatherford, Texas 76086, U.S.A. (**Orders:** shop.brit.org, 1-817-332-4441). $20.00, 345 pp., color photos, illus. glossary, glossary, bib., index, 9.5" × 11.25".

Wildlife Biologist Ricky Linex has created a fine resource for botanists, farmers, land managers, wildlife managers, plant enthusiasts, students, and anybody interested in the flora of Texas and the southern plains states. Though the title specifies its regional focus as North Central Texas, the book should also prove useful to readers in Oklahoma and even parts of New Mexico.

The concept for the book came from a previous USDA-NRCS publication, *Common Rangeland Plants of the Texas Panhandle* by Clint Rollins. Linex took the idea and repeated it for an area that includes not only the Rolling Plains vegetational area, but also the Cross Timbers, Blackland Prairie, and Post Oak Savannah areas.

The book is laid out in sections, with forbs, grasses, and woody plants being separated out and arranged taxonomically by first family then genus. Though some of the family names are old (Asclepiadaceae and Chenopodiaceae instead of Apocynaceae and Amaranthaceae), the author does include synonyms for a good portion of the 324 taxa, ostensibly for "those of us who first learned the scientific names more than a few years ago".

Each taxon page is headed in large print by the most-used common name, with alternative common names listed out to the side. A small area in the upper left or right corner of each page includes the following items: scientific name, family name, common name for family, origin, longevity, season of growth, bloom period, and distribution relative to vegetational areas. In addition, each page includes three narrative sections on identification, value, and management (hence the book's subtitle), and it is these last two that make this book different from other regional guides. The value section on Justicia americana (water-willow), for example, states "Livestock and deer graze upon water-willow, and the plants will be utilized extensively when other forage becomes scarce during hot, dry summers …" The management section for the same species reads, "Under heavy use by livestock and native or exotic animals, water-willow will be browsed close to the ground. Proper stocking rates and rotational grazing will ensure this forb will remain rooted in wet areas where it helps provide stability to stream banks."

Each page boasts from 3 to 6 color photographs (typically 4 or 5), many of which were taken by the author himself. A good number of pages contain a standardized seed photo—several seeds against an orange background with a 1/16 inch ruler for scale. This standardization makes these photos easy to pick out among the photo-heavy pages, and I am thankful that the author made this decision.

Lots of extras are sprinkled into the book. Between the forb and grass section one can find the "Checklist and Value of Cattle Forage Plants of North Central Texas" as well as a nice little essay on grass by John James Ingalls (1833–1900). Between the grass and woody sections are "Preference Categories of Deer Food Plants" written by Steve Nelle, "Checklist and Value of Deer Food Plants of North Central Texas," and a poem about mesquites by Frank Grimes. All of this is capped off with an illustrated glossary (mostly about leaf characteristics and grass morphology), standard textual glossary, list of references, common name index, and scientific name index.

The book itself is printed on thick gloss paper (likely at least 80–100 lb text) where the color images and the large (likely 12 pt) font really stand out nicely. The book is spiral bound and thus lies flat when open, and the cover is heavy gloss/laminated card stock. Since I'm almost certain the first run will sell out in quick measure, the only suggestion I have for the author for his second printing is to switch from the spine-over-spiral cover to a basic spiral/comb cover. (Spine-over spiral gives spiral books a printable spine by using one continuous sheet that wraps around the wire spiral/comb to create both covers and a spine, with only the back portion actually attached to the spiral.) Although it makes the book look great on a shelf, it's a bit clumsy to handle, and I for one plan to be using my copy so much that it might NEVER sit on the shelf!—*Brooke Byerley Best, PhD, Editor & Botanist, Botanical Research Institute of Texas, Fort Worth, Texas, U.S.A.*

ESTRUCTURA DE UN ZACATAL DE TOBOSO (*HILARIA MUTICA*: POACEAE) ASOCIADO A SUSTRATO ÍGNEO EN EL NORESTE DE COAHUILA, MÉXICO

Juan A. Encina-Domínguez

Laboratorio de Sistemas de Información Geográfica
Universidad Autónoma Agraria Antonio Narro
Buenavista, Saltillo 25315
Coahuila, MÉXICO
jaencinad@gmail.com

Jesús Valdés-Reyna y José A. Villarreal-Quintanilla

Departamento de Botánica
Universidad Autónoma Agraria Antonio Narro
Buenavista, Saltillo 25315
Coahuila, MÉXICO

RESUMEN

Con el objetivo de evaluar la estructura y diversidad de especies en un zacatal de toboso (*Hilaria mutica* (Buckley) Benth.) en la Planicie Costera del Golfo, se establecieron 20 sitios, en parcelas de 100 m^2. Se cuantificaron las arbustivas, las herbáceas se midieron en tres parcelas de 2 m^2 por sitio, en ambos estratos se tomó altura y cobertura de las especies. Se calcularon atributos de densidad, cobertura y frecuencia, además del valor de importancia relativo (VIR) por especie. Se calculó la diversidad con el índice de Shannon-Wiener. La flora está integrada por 32 familias, 89 géneros y 109 especies, las familias más importantes son: Asteraceae con 16 especies, Fabaceae (12), Euphorbiaceae (10) y Poaceae (9). Se registraron 17 especies consideradas como malezas ruderales. Se cuantificaron arbustos espinosos e inermes como: *Acacia rigidula* con 625 ind/ha, *Opuntia lindheimeri* 650 ind/ha, y *Aloysia gratissima* 469 ind/ha, su densidad es mayor en áreas disturbadas debido al pastoreo. El estrato herbáceo está dominado por *Hilaria mutica* con dominancia relativa de 64.96% y VIR de 30.65%, la riqueza se incrementa en época de lluvias, donde las anuales más abundantes son: *Ambrosia confertiflora*, *Aphanostephus ramosissimus* y *Ratibida columnifera*. El estrato arbustivo tiene una riqueza de 33 especies, índice de diversidad 2.67 nats. Para el estrato herbáceo se registraron 55 especies y el índice de diversidad es 3.050 nats. El zacatal presenta evidencias de sobrepastoreo y puede ser invadido por malezas ruderales, y a medio plazo ser sustituido por el matorral espinoso que crece en áreas aledañas.

Palabras Clave: Florística, pastizal, riqueza de especies, vegetación

ABSTRACT

With the objective to survey and delineate the structure and diversity of species of a toboso grassland (*Hilaria mutica* (Buckley) Benth.) in the Gulf Coastal Plain (Coahuila, México), 20 sampling sites were established in plots of 100 square meters. The survey quantified shrubs, while the forbs within 3 plots of 2 square meters per site, for both strata, height and species coverage were measured. Density, canopy cover, frequency and the value of relative importance (VIR) per species were calculated. The diversity was estimated using the Shannon-Wiener index. The flora includes 32 families, 89 genera, and 109 species; the families with the highest number of species are: Asteraceae (16), Fabaceae (12), Euphorbiaceae (10), and Poaceae (9). There were 19 species recorded as weeds. The density of several shrubs such *Acacia rigidula* 625 ind/ha, *Opuntia lindheimeri* 650 ind/ha, and *Aloysia gratissima* 469 ind/ha is related to the degree of disturbance by cattle grazing. The herbaceous stratum is dominated by *Hilaria mutica* with relative dominance of 64.96% and 30.65% VIR. The richness of the herbaceous flora increases during the rainy season. The most abundant herbs are: *Ambrosia confertiflora, Aphanostephus ramosissimus* y *Ratibida columnifera*. The shrub stratum has a richness of 33 species, with a diversity index of 2.67 nats. For the herbaceous stratum there were 55 species recorded and the diversity index is 3.050 nats. The grassland shows evidence of overgrazing and being invaded by ruderal weeds. In the short term it can be replaced by thorn scrub from surrounding areas.

Key Words: Grassland, floristic, species richness, vegetation

Los zacatales son comunidades vegetales con dominancia de especies de la familia Poaceae (gramíneas o zacates) (Rzedowski 1966), se desarrollan en valles donde los suelos son de mediana profundidad, así como en laderas poco inclinadas y mesetas, con amplia distribución en México y Norteamérica (Rzedowski 1975, 2006). En Coahuila se distribuyen en porciones aisladas que varían en tamaño a través del estado y ocupan un área aproximada del 8% de la superficie estatal (Villarreal & Valdés 1992–93). Según el ordenamiento ecológico de Coahuila, los zacatales ocupan 6.18% de la superficie estatal (ICE 2001) e incluye el zacatal natural o climático, así como el gipsófilo (Pinkava 1984) y halófilo (Estrada et al. 2010) determinados por condiciones edáficas. Es frecuente que se presenten asociados con otro tipo de vegetación, pero con mayor frecuencia con el

Matorral Xerófilo, por lo que la composición de especies es variada, sin embargo, domina el estrato herbáceo, con arbustos y árboles que crecen aislados.

Los zacatales dominados por el zacate toboso (*Hilaria mutica*) son frecuentes en los márgenes de lagunas intermitentes y valles de cuencas endorreicas en áreas con suelos arcillosos, limosos y profundos con alto contenido de sales, se ubican en altitudes entre 1,300 a 1,600 m, son propios del oeste de Coahuila (Muller 1947), centro-este del estado de Chihuahua (Shreve 1942; Henrickson & Johnston 1986), en el Valle de Janos, en el noroeste de Chihuahua (Vega-Mares et al. 2014), en el noreste de Durango (Gentry 1957; González et al. 2007) y en el noroeste de Nuevo León (Briones & Villarreal 2001). Como parte de la composición se presentan arbustos bajos y esparcidos de chamizo (*Atriplex canescens*), nopales (*Opuntia* spp.) y mezquite (*Prosopis glandulosa*), entre otras especies. De acuerdo con Rzedowski (2006), los zacatales de toboso no están restringidos a suelos alcalino-salinos, sino que también prosperan en otros que tienen drenaje algo deficiente y textura fina.

En México, estos zacatales se han utilizado para el pastoreo intensivo de ganado bovino, los cuales son de excelente valor forrajero cuando se aprovechan aplicando una administración adecuada de agostaderos, sin embargo, el mal manejo al que han estado sometidos, no permite obtener el mayor rendimiento (Rzedowski 2006). Los zacatales naturales se encuentran dentro de los ecosistemas que han sido más perturbados por la influencia humana (Hannah et al. 1995). Se ha documentado que el sobrepastoreo impide el desarrollo de especies forrajeras, propiciando la invasión de plantas indeseables como anuales de tipo ruderal y arbustos espinosos que son dispersados por el ganado, además, de que el pisoteo excesivo causa compactación del suelo, lo que reduce la cobertura de la vegetación (Hobbs & Huenneke 1992; Rzedowski 2006) y, de acuerdo con Kahmen et al. (2002) altera la composición, diversidad y estructura de la vegetación.

En Chihuahua y el oeste de Coahuila la superficie de los zacatales de *Hilaria mutica* se ha reducido debido a la apertura de áreas agrícolas, ya que algunos zacatales se ubican en terrenos fértiles con baja salinidad y textura arcillosa, por lo que son utilizados para cultivar alfalfa, algodón y maíz, con elevado suministro de agua a través de riegos periódicos (obs. pers.).

En el noreste de Coahuila se presenta un zacatal de *Hilaria mutica* sobre un afloramiento de roca ígnea, el cual incluye una elevada riqueza de herbáceas. En esta comunidad se asocian arbustos espinosos e inermes propios del Matorral Tamaulipeco como *Acacia rigidula*, *Opuntia lindheimeri* y *Prosopis glandulosa* var. *glandulosa*, su abundancia está relacionada con el grado de disturbio debido al sobrepastoreo. Con el presente estudio se pretende evaluar la riqueza y diversidad de especies presentes, además de describir la estructura del estrato herbáceo y arbustivo del zacatal.

ÁREA DE ESTUDIO

El área de estudio se localiza en el municipio de Sabinas al noreste del estado de Coahuila, con extremos de latitud entre 27°45' y 26°20'N y de longitud entre 101°40' y 100°30'W (Fig. 1). Forma parte de la provincia fisiográfica Grandes Llanuras de Norte América y la subprovincia Llanuras de Coahuila y Nuevo León, conformadas por extensas planicies, lomeríos bajos y escasas montañas con intervalos altitudinales entre 150 y 1,000 m (ICE 2001). La altitud media en el área es de 350 m. Se ubica en la región hidrológica RH-24 "Bravo-Conchos", la corriente permanente más importante es el río Sabinas que se origina en la Sierra Santa Rosa, el cual fluye a la presa Venustiano Carranza (Don Martín). En el área dominan las rocas extrusivas del Pleistoceno formadas por basalto. Los suelos son aluviales, de textura fina y media, de profundidad variable, moderadamente alcalinos, con bajo contenido de materia orgánica, de color café o gris (ICE 2001).

El área se ubica en una planicie donde las altitudes oscilan entre 355 a 415 m, sobresale el cerro de Agua Dulce, su parte más alta tiene de 500 m de altitud, la llanura corresponde a un afloramiento ígneo que ocupa un área aproximada de 29,340 ha, provenientes de roca ígnea extrusiva, tipo basalto, del Cenozoico, de la era Cuaternaria. Los suelos son arcillosos, que se mezclan, con alta proporción de arcillas expandibles, forman grietas anchas y profundas cuando están secos; posee un 40% o más de gravas u otros fragmentos gruesos promediado en una profundidad de entre 50 a 100 cm de la superficie del suelo (FAO 2007). Como unidad codominante, se presenta el suelo vertisol, asociado con calificadores del tipo calcárico-endoléptico. Son suelos de textura fina donde la fase rudica es pedregosa.

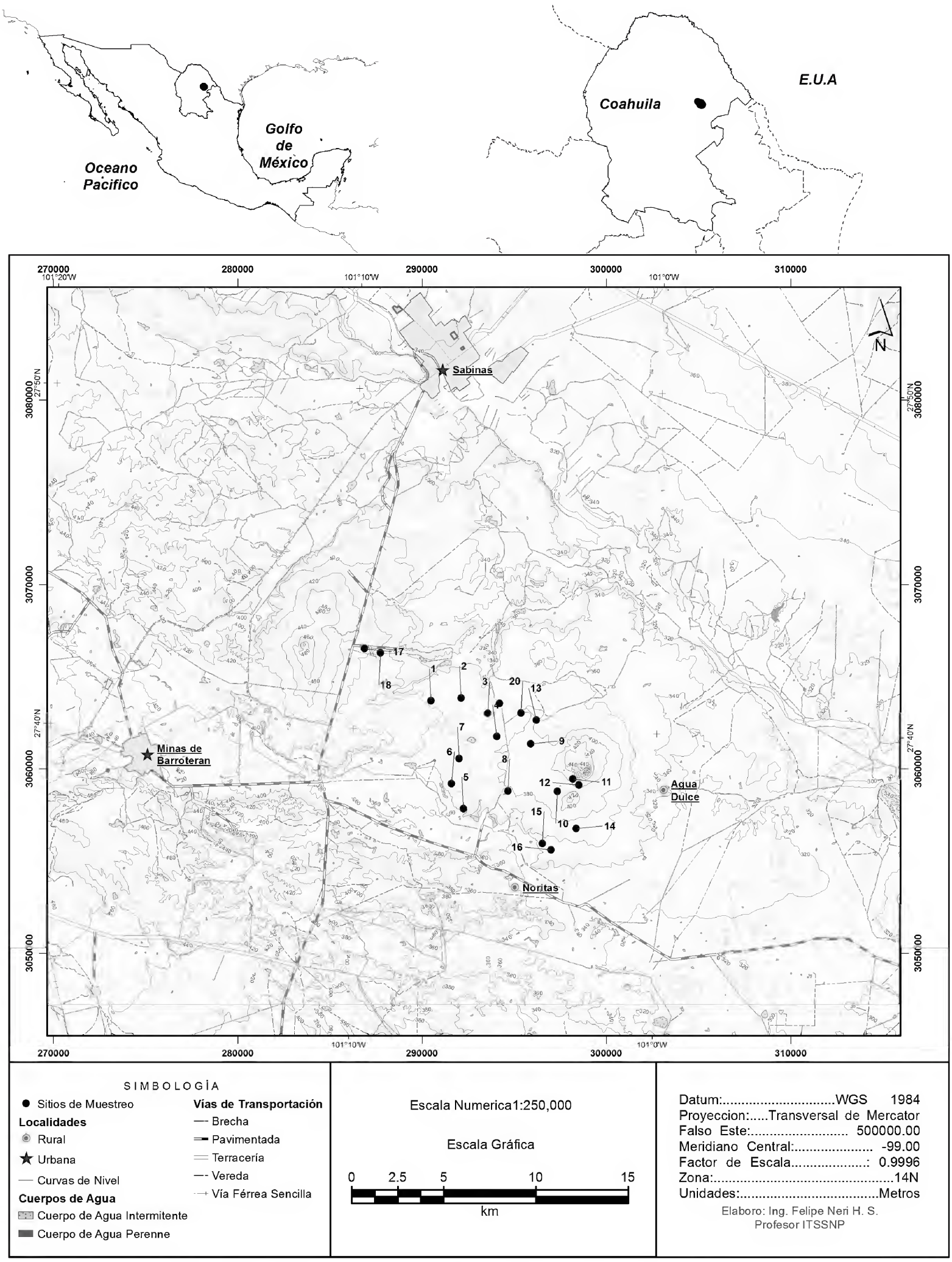


Fig. 1. Localización del área de estudio y ubicación de los sitios de muestreo.

El clima de acuerdo con el sistema de clasificación de Koppen (modificado por García 1973) es seco muy cálido y cálido BS0(h'). La precipitación promedio es 454 mm al año y la temperatura media es 22°C, el mes más frío es enero con 3 a 4°C y el más caliente es julio, con una variación de 35 a 37°C, la época lluviosa inicia en mayo y termina en octubre, se presenta sequía intraestival entre junio y julio, la temporada de lluvias coincide con los meses más calientes del año. Los vientos dominantes provienen del noreste, en el invierno se presentan vientos fríos procedentes del hemisferio norte (ICE 2001).

La cubierta vegetal del área según Villarreal & Valdés (1992–93) es de porte arbustivo, la vegetación más abundante es Matorral Tamaulipeco (Muller 1947), el cual se presenta en planicies y lomeríos, entre 240 y 850 m de altitud, ubicados al este de la sierras Santa Rosa, Obayos y Pájaros Azules, donde dominan arbustos espinosos y algunos inermes, las especies más frecuentes son: *Acacia rigidula*, *Celtis pallida*, *Karwinskia humboldtiana, Leucophyllum frutescens*, *Opuntia lindheimeri* y *Prosopis glandulosa* var. *glandulosa*, las herbáceas más abundantes son gramíneas de los géneros: *Aristida, Bouteloua* y *Tridens*. El área estudiada es parte de ranchos cinegéticos, donde se presenta una densidad alta de venado cola blanca (*Odocoileus virginianus* var. *texanus*) además de que los zacatales son utilizados para realizar el pastoreo intensivo de ganado bovino.

METODOLOGÍA

Para la medición de la vegetación se utilizó el método de parcela (Mueller-Dombois & Ellenberg 1974). Se levantaron 20 sitios de muestreo donde las especies arbustivas se evaluaron en parcelas de 100 m^2, mientras que las especies del estrato herbáceo se midieron en tres parcelas de 2 m^2 por sitio de muestreo, en ambos estratos se tomó la altura y cobertura de las especies. En cada sitio se registró la altitud y coordenadas geográficas con un geoposicionador. Se realizaron colectas de material botánico durante el verano y otoño, las cuales fueron identificadas y depositadas en el herbario ANSM (Saltillo, Coahuila, México) (Holmgren & Holmgren 1990). Los nombres científicos válidos así como los autores son de acuerdo a la base de datos del Missouri Botanical Garden (http://www.tropicos.org). Se calcularon los atributos de la vegetación como la densidad, frecuencia y cobertura de copa para cada especie, los valores relativos de estas variables se sumaron para calcular el valor de importancia relativo (en lo sucesivo VIR) (Mueller-Dombois & Ellenberg 1974). También se calculó la diversidad con el índice de Shannon-Wiener (H'), donde se utilizó logaritmo natural (Magurran 2004), así como la equitatividad (E) de acuerdo con Pielou (1966) y el índice de riqueza de especies de Margalef (Magurran 2004).

RESULTADOS Y DISCUSIÓN

Como parte de la flora se registraron 109 especies, distribuidas en 32 familias y 89 géneros (ver Anexo 1), esta cifra representa el 3.58% de la flora reportada para Coahuila (Villarreal 2001). De acuerdo con Rzedowski (1992) los pastizales y matorrales albergan aproximadamente 6,000 especies (20% de la flora total), el 1.81% de esas especies se presentan en el zacatal de *Hilaria mutica*. Las familias más importantes son: Asteraceae con 16 especies, Fabaceae (12) y Euphorbiaceae (10) (Tabla 1), la misma tendencia se presenta en el pastizal halófilo del noreste de México estudiado por Estrada et al. (2010) y de forma general con los pastizales calcifilos de Guanajuato (Rzedowski & Calderón de Rzedowski 1995). Tales familias son de igual forma, las de mayor riqueza de especies en pastizales halófilos del Valle de Janos, Chihuahua (Vega-Mares et al. 2014) y en un pastizal del suroeste de Querétaro (Gómez-Sánchez et al. 2011). Los géneros con mayor riqueza, con al menos tres taxones, son: *Acacia*, *Croton, Euphorbia* y *Verbena*. De la flora observada, las monocotiledóneas representan el 13.34% y las dicotiledóneas el 86.66%. Con relación a las formas de vida, dominan las hierbas, de estas, 55 especies son perennes y 17 son anuales, 30 especies son arbustos y 7 crasicaules. De las 32 familias registradas, 47% (15 familias) están representadas por una especie. La riqueza de Asteraceae puede atribuirse a sus adaptaciones evolutivas como fertilidad alta, eficiencia en dispersión y plasticidad química (Villaseñor 1993). El estrato arbustivo tiene una riqueza de 33 especies, posee un índice de diversidad 2.675 nats, equitatividad 76.53%. Por su parte, el índice de riqueza es de 4.846. Para el caso del estrato herbáceo, se registró una riqueza de 55 especies, posee una diversidad de 3.050 nats, una equitatividad 76.12% y un índice de riqueza de 6.887. En el caso del índice de diversidad obtenido para el estrato arbustivo es medio y para el herbáceo es alto de acuerdo con el criterio de Margalef (1972) que indican que valores superiores a 3.0 nats son considerados altos.

Tabla 1. Familias con más riqueza de géneros y especies en la flora del zacatal de *Hilaria mutica*.

Familias	Número de géneros	Número de especies
Asteraceae	16	13
Fabaceae	12	8
Euphorbiaceae	10	5
Poaceae	9	9
Verbenaceae	8	7
Malvaceae	8	7
Cactaceae	7	6
Brassicaceae	3	3
Solanaceae	3	3
Lamiaceae	3	2

De las 109 especies registradas para el zacatal de *Hilaria mutica*, 105 especies (96%) están reportadas para la flora de las planicies del sur de Texas de acuerdo con Hatch et al. (1990), esto, debido a que comparten condiciones ecológicas, pues ambas áreas se ubican en la provincia florística de la Planicie Costera del Noreste, la cual tiene influencia tropical (Rzedowski 2006). Con respecto a la vegetación del ecotono para el noroeste de Nuevo León reportado por Briones & Villarreal (2001), tiene una elevada similitud ya que comparte 79 especies (71%). Gran parte de las especies de la familia Fabaceae son comunes en el norte del estado de Nuevo León (Estrada et al. 2005). Por otro lado, con los pastizales halófilos del noreste de México estudiados por Estrada et al. (2010), comparte 17 especies (15.6%), la poca similitud es debido a que estos pastizales se localizan en la provincia del Altiplano Mexicano y que incluyen flora de afinidad xérica. La mayor parte de los géneros de la flora presentan afinidad geográfica meridional (Rzedowski 1965), por lo que presentan un vínculo neotropical, algunas especies son exclusivas de la provincia florística Planicie Costera del Noreste como *Acacia rigidula* y *Leucophyllum frutescens*, entre otras. Especies como *Hilaria mutica*, *Jatropha dioica* y *Larrea tridentata* son propias de la Altiplanicie Mexicana y extienden su distribución hasta el noreste de Nuevo León (Briones & Villarreal 2001).

En el área se presentan dos especies bajo estatus de conservación en la NOM-059-SEMARNAT-2010 (SEMARNAT 2010), las cuales son: *Amoreuxia wrightii* en la categoría de "en peligro de extinción" y de acuerdo con Calderón de Rzedowski (1994) la localidad tipo de la especie está en Texas, donde habita desde el suroeste de tal estado y en el norte y noreste de México, con distribución disyunta hasta Yucatán y Sudamérica; en el área es abundante en el estrato herbáceo del zacatal, con densidad de 2,083 ind/ha, su presencia es más evidente en la estación lluviosa. Se localizó también a *Echinocereus poselgeri*, especie con distribución en el Matorral Tamaulipeco, en el noreste de México (Guzmán et al. 2003), registrada para la flora de Texas por Hatch et al. (1990), está catalogada como "sujeta a protección especial" en la mencionada norma. Por otra parte se colectaron dos plantas endémicas de la región centro de Coahuila, de acuerdo con Villarreal & Encina (2005) como: *Gaillardia coahuilensis*, común en la época de lluvias y *Mimosa turneri*, con pocos individuos que crecen aislados. Las especies conocidas en el área estudiada a partir de uno o pocos individuos se les puede considerar raras (Rabinowitz et al. 1986), en el zacatal estudiado se encontraron en esta condición a las siguientes: *Apodanthera undulata*, *Euphorbia johnstonii*, *Jatropha cathartica*, *Malvella sagittifolia, Mimosa unipinnata* y *Rivina humilis*.

Como parte de la flora se colectaron 17 especies (15.6% de la flora del zacatal estudiado) consideradas por la CONABIO (2014) como malezas de tipo ruderal, las que se han registrado en varios estados de México, la mayoría de las especies ruderales tienen estatus migratorio como nativas de México y solo dos *Malvastrum coromandelianum* y *Solanum elaeagnifolium* son consideradas probablemente nativas. En la Tabla 2 se comparan 13 especies que se presentan en otros pastizales y matorrales de México, de estas, comparte cuatro especies con los pastizales calcifilos citados para Guanajuato por Rzedowski & Calderón de Rzedowski (1995), ocho son parte de la vegetación de la región de Ojuelos, Jalisco reportada por Harker et al. (2008), siete son ruderales con distribución en los pastizales halófilos del noreste de México (Estrada et al. 2010), mientras que con los

Tabla 2. Comparación de las principales especies ruderales del zacatal de *Hilaria mutica* con otros pastizales y matorrales de México.

Especie	Este estudio	Guanajuato. Rzedowski & Calderón de Rzedowski (1995)	Ojuelos, Jalisco. Harker et al. (2008)	Noreste de México. Estrada et al. (2010)	Janos, Chihuahua. Vega-Mares et al. (2014)
Ambrosia confertiflora	X			X	X
Aphanostephus ramosissimus	X	X	X		X
Apodanthera undulata	X				X
Desmanthus virgatus	X			X	
Euphorbia nutans	X		X		
Glandularia bipinnatifida	X	X	X		
Lepidium virginicum	X		X		X
Parthenium hysterophorus	X			X	
Portulaca pilosa	X	X	X		X
Sida abutifolia	X	X	X	X	X
Solanum elaeagnifolium	X		X	X	X
Sphaeralcea angustifolia	X		X	X	X
Sphaeralcea hastulata	X			X	X

pastizales halófilos del Valle de Janos, Chihuahua estudiados por Vega-Mares et al. (2014) comparte nueve especies. Algunas malezas como *Aphanostephus ramosissimus*, *Sida abutifolia, Solanum elaeagnifolium* y *Sphaeralcea angustifolia*, están presentes de la mayoría de las localidades, esto debido a que son comunes en el centro-norte de México, mientras que las otras especies tienen menor rango de distribución o bien se tienen menos reportes de su presencia en comunidades naturales.

En áreas con sobrepastoreo, el zacatal incluye un estrato arbustivo aislado que integra un matorral abierto, las especies dominantes son arbustos espinosos que poseen alturas de 0.98 a 1.50 m (Fig. 2), los que tienen mayor densidad y VIR son: *Acacia rigidula* con 625 ind/ha y VIR de 17.53%, *Opuntia lindheimeri* con 650 ind/ha y VIR de 12.84%, además del arbusto inerme: *Aloysia gratissima* con 469 y VIR de 10.17% (Tabla 3), se presenta un estrato subarbustivo con altura de 0.50 a 0.54 m, donde domina *Lippia graveolens* con 613 ind/ha y *Jatropha dioica* con 706 ind/ha. Se registraron colonias aisladas de *Echinocereus stramineus* con densidad de 50 ind/ha, además de *Echinocactus texensis* y *Sclerocactus scheeri,* las que tienen densidad inferior a 10 ind/ha. En áreas con suelos profundos y áreas donde se acumula la humedad se presenta *Prosopis glandulosa* var. *glandulosa*, su altura media es 1.42 m, con densidad de 156 ind/ha y VIR de 4.99%, tales especies leñosas son reportadas por Mata (2010) para asociaciones del matorral xerófilo ubicado en el centro-este de Coahuila, en el matorral espinoso reporta para *A. rigidula* una densidad de 1,675 ind/ha, la cual es más elevada que en el zacatal estudiado. Un zacatal similar es reportado por Briones & Villarreal (2001) para el noroeste de Nuevo León, donde el estrato herbáceo alcanza hasta 50 cm de altura y está representado por *Hilaria mutica*, crecen arbustos esparcidos de 2.0 m de alto de los géneros *Acacia*, *Opuntia* y *Prosopis*, así como *Flourensia cernua* y *Lycium berlandieri*.

En el estrato herbáceo el zacate toboso (*Hilaria mutica*) tiene alta dominancia relativa con 64.963% y VIR de 30.65%, abundante en los sitios con menor intensidad de pastoreo del ganado bovino, el cual forma "macollos" con alturas de 20 a 30 cm (Tabla 4 y Fig. 2). La riqueza del estrato herbáceo se incrementa en la temporada de lluvias y en áreas con mayor disturbio por el pastoreo, dos aspectos mencionados por Pausas & Austin (2001) como influyentes en la riqueza de especies. De forma codominante se presentan tres especies anuales como: *Ratibida columnifera* (con VIR de 7.42%), *Ambrosia confertiflora* (VIR 6.45%) y *Aphanostephus ramosissimus* (VIR 5.95%), las dos últimas consideradas malezas ruderales, tales especies son dispersadas por el ganado, el que además facilita su establecimiento (Hobbs & Huenneke 1992). Algunas especies perennes que registran mayores valores de densidad y VIR son: *Desmanthus virgatus* (con VIR de 3.67%), *Bouteloua trifida* (VIR 3.47%) y *Phyllanthus polygonoides* (VIR 3.46%). El zacate *Hilaria mutica* se presenta en tres de las cinco asociaciones del matorral xerófilo estudiado por Mata (2010), es el dominante en el estrato herbáceo del matorral de *Prosopis*

Fig. 2. Arriba: zacatal dominado por *Hilaria mutica* con arbustos aislados de *Opuntia lindheimeri*, principal especie en las áreas con sobrepastoreo, Abajo: zacatal de *Hilaria mutica* con presencia de arbustos de *Acacia rigidula* y *Opuntia lindheimeri*, al fondo se observa el cerro de Agua Dulce principal elevación del área de estudio.

Tabla 3. Atributos estructurales de las especies arbustivas del zacatal de *Hilaria mutica*.

Especie	Altura media (cm)	Dom. Rel. (%)	Dens. (ind/ha)	Dens. Rel. (%)	Frec. Rel. (%)	VIR (%)*
Acacia rigidula	150.93	30.727	625	13.550	8.333	17.537
Opuntia lindheimeri	98.34	13.832	650	14.092	10.606	12.843
Aloysia gratissima	115.82	10.505	469	10.163	9.848	10.172
Lippia graveolens	54.21	5.280	613	13.279	7.576	8.712
Jatropha dioica	50.81	2.737	706	15.312	5.303	7.784
Prosopis glandulosa	142.71	5.537	156	3.388	6.061	4.995
Eysenhardtia texana	134.89	6.260	194	4.201	3.788	4.750
Acacia constricta	94.17	3.573	94	2.033	4.545	3.384
Larrea tridentata	100.78	4.200	138	2.981	2.273	3.151
Cylindropuntia leptocaulis	69.11	1.782	106	2.304	5.303	3.130
Karwinskia humboldtiana	85.81	2.194	94	2.033	4.545	2.924
Viguiera stenoloba	73.14	2.187	150	3.252	1.515	2.318
Guaiacum angustifolium	74.07	0.503	56	1.220	3.788	1.837
Echinocereus stramineus	24.60	0.263	50	1.084	3.788	1.712
Ziziphus obtusifolia	123.75	0.969	25	0.542	3.030	1.514
Leucophyllum frutescens	130.70	1.590	63	1.355	1.515	1.487
Croton incanus	88.16	0.826	119	2.575	0.758	1.386
Mimosa turneri	93.13	2.035	50	1.084	0.758	1.292
Castela erecta	130.00	0.718	19	0.407	2.273	1.132
Yucca treculeana	175.00	0.487	19	0.407	2.273	1.055
Echinocactus texensis	12.00	0.003	6	0.136	0.758	0.299
Sclerocactus scheeri	13.00	0.002	6	0.136	0.758	0.298
Echinocereus poselgeri	34.00	0.001	6	0.136	0.758	0.298
Otras 10 especies		3.791	200	4.336	9.848	5.992
Total		100.00	4,613	100.00	100.00	100.00

* Dom. Rel. = Dominancia relativa, Dens. = Densidad, Dens. Rel. = Densidad relativa, Frec. Rel. = Frecuencia relativa, VIR (Valor de importancia relativo) = Dom. rel. + Dens. rel. + Frec. rel. / 3.

glandulosa-Castela texana, el cual tiene una densidad de 26,500 ind/ha, dominancia relativa de 34.64% y VIR de 18.79%, tales valores son inferiores a los registrados en el presente estudio.

La elevada riqueza de especies herbáceas registrada en el zacatal estudiado está influenciada además por el tipo de suelo, el cual se deriva de roca ígnea, los cuales aportan más cantidad de nutrientes (Buckman & Brady 1970; Pausas & Austin 2001) que incrementan el número de especies, en especial de herbáceas. Por otra parte, se ajusta al modelo de disturbio intermedio citado por Hobbs & Huenneke (1992), el cual señala que, a niveles intermedios de disturbio, la riqueza alcanza su mayor valor.

La distribución del matorral espinoso en algunos sitios donde el estrato herbáceo está dominado por zacate toboso (*Hilaria mutica*) al parecer corresponde a una condición intermedia de sucesión ecológica, inducida por el apacentamiento excesivo, ya que arbustivas como *Opuntia lindheimeri*, *Acacia rigidula* y *Prosopis glandulosa* var. *glandulosa* son invasoras comunes en zacatales degradados (Golubov et al. 2001; Sánchez et al. 2007), de igual manera, el carácter invasivo también se reconoce para *Castela erecta* en el sur de Texas (Taylor et al. 1999). Algunas especies de mezquite (*Prosopis* spp.) son consideradas invasoras agresivas de agostaderos (Andrade et al. 2007). En varios estados del norte de México especies como *Prosopis glandulosa* var. *glandulosa*, *Acacia berlandieri, A. constricta* y *A. rigidula* son abundantes sobre grandes extensiones, asociados a comunidades de matorral xerófilo. Algunas especies dominan en áreas con disturbio y constituyen un problema en campos de cultivo abandonados, donde su erradicación es difícil, destacando en este grupo *Acacia farnesiana* y *Mimosa aculeaticarpa* (Estrada & Martínez 2003).

La fuerte presión por el pastoreo desordenado de bovinos ha provocado el sobrepastoreo del zacatal estudiado (obs. pers.), lo cual ha propiciado la invasión de arbustos no apetecibles y especies ruderales (Richardson et al. 2000, Gómez-Sánchez et al. 2011) y ha disminuido la capacidad forrajera de la comunidad al ocasionar en algunas áreas la conversión del zacatal por un matorral espinoso debido a la invasión de especies leñosas

Tabla 4. Atributos estructurales de las especies herbáceas del zacatal de *Hilaria mutica*.

Especie	Altura media (cm)	Dom. Rel. (%)	Dens. (ind/ha)	Dens. Rel. (%)	Frec. Rel. (%)	VIR (%)*
Hilaria mutica	25.82	64.963	112,917	21.330	5.677	30.657
Ratibida columnifera	29.08	8.178	46,875	8.855	5.240	7.424
Ambrosia confertiflora	14.76	5.661	42,500	8.028	5.677	6.455
Aphanostephus ramosissimus	15.53	3.874	41,667	7.871	6.114	5.953
Desmanthus virgatus	9.08	1.052	27,292	5.155	4.803	3.670
Bouteloua trifida	6.99	1.271	39,167	7.399	1.747	3.472
Phyllanthus polygonoides	9.84	0.581	19,583	3.699	6.114	3.465
Euphorbia prostrata	4.77	0.967	14,167	2.676	3.930	2.525
Sida abutifolia	8.29	0.787	11,875	2.243	3.930	2.320
Argythamnia humilis	5.78	1.094	13,333	2.519	3.057	2.223
Melampodium cinereum	11.90	1.157	12,083	2.283	2.620	2.020
Gutierrezia sphaerocephala	20.95	0.385	14,375	2.715	2.620	1.907
Thymophylla pentachaeta	9.22	0.507	11,667	2.204	2.620	1.777
Thymophylla micropoides	3.68	0.605	17,917	3.384	1.310	1.766
Aneilema karwinskiana	19.88	0.815	4,167	0.787	2.620	1.408
Sphaeralcea hastulata	7.40	0.312	8,125	1.535	2.183	1.344
Parthenium hysterophorus	14.22	0.687	5,208	0.984	2.183	1.285
Urochloa fasciculata	8.58	0.487	8,542	1.614	1.310	1.137
Amoreuxia wrightii	14.69	0.250	2,083	0.394	2.620	1.088
Dalea pogonathera	10.40	0.113	3,542	0.669	2.183	0.988
Gutierrezia texana	25.08	0.415	8,750	1.653	0.873	0.980
Gaillardia coahuilensis	19.75	0.911	3,750	0.708	0.873	0.831
Scutellaria potosina	6.50	0.021	625	0.118	0.873	0.338
Otras 32 especies	-	4.905	59,167	11.177	28.821	14.968
Total	-	100.00	529,375	100.00	100.00	100.00

* Dom. Rel. = Dominancia relativa, Dens. = Densidad, Dens. Rel. = Densidad relativa, Frec. Rel. = Frecuencia relativa, VIR (Valor de importancia relativo) = Dom. rel. + Dens. rel. + Frec. rel. / 3.

(Halpern et al. 2010; Rice et al. 2012; Amodeo & Zalba 2013). Desde hace casi cuatro décadas, de acuerdo con Rzedowski (1975), en México se reconocía que la presencia humana en pastizales producía una fuerte influencia en su extensión, composición y dinámica, sin embargo, la magnitud de estos cambios es difícil de evaluar. Por lo anterior se prevé, que de continuar el libre pastoreo en el zacatal estudiado, las malezas registradas podrían ser más abundantes e inclusive reemplazar algunas especies nativas, lo anterior de acuerdo con Baruch et al. (1989) quienes mencionan que las ruderales son mejores competidoras y capaces de desplazar a las especies nativas. El zacatal podría ser además reemplazado por arbustos espinosos como *Acacia rigidula* y *Opuntia lindheimeri*, propios de los matorrales adyacentes, estas son especies que el ganado no consume y dominan en sitios sobrepastoreados, de acuerdo con Nai-Bregaglio et al. (2002) son llamadas especies crecientes. Por otra parte, las especies preferidas por el ganado bovino como *Hilaria mutica* que son más nutritivas (Sternberg et al. 2000) pueden disminuir o desaparecer de este zacatal.

Anexo 1

Listado florístico del zacatal de *Hilaria mutica* en el centro de Coahuila.

Las colectas corresponden al primer autor, los números de colecta los antecede la inicial E. Después del nombre científico se cita (A) para las especies anuales, el resto son perennes. Para las especies consideradas malezas de tipo ruderal de acuerdo con el criterio de CONABIO (2010) se anota (M).

MAGNOLIOPHYTA
DICOTYLEDONEAE (MAGNOLIOPSIDA)

Acanthaceae: *Ruellia occidentalis* (A. Gray) Tharp. & Barkley, E 1560, 2472, 2501, 2593, 2737; *R. nudiflora* (Engelm. & A. Gray) Urb., E 1639, 1950, 2659.

Apocynaceae: *Mandevilla macrosiphon* (Torr.) Pichon, E 1952, 2408, 2430, 2602, 2640.

Asclepiadaceae: *Asclepias asperula* (Decne.) Woodson, E 2739.

Asteraceae: *Ambrosia confertiflora* DC., (M) E 2490a; *Aphanostephus ramosissimus* DC., (A, M), E 2363, 2403, 2523, 2549, 2975; *Chaetopappa bellioides* (A. Gray) Shinners, E 2481, 2498, 2562;

Gaillardia coahuilensis B.L. Turner, (A), E 2422, 2849; *Gutierrezia sphaerocephala* A. Gray, (A), E 2359; *G. texana* (DC.) Torr. & A. Gray, (A), E 1836, 2522, 2915, 2925; *Melampodium cinereum* DC., E 2365, 2417, 2597, 3010; *Palafoxia texana* DC., (A), E 1944, 2738; *Parthenium hysterophorus* L., (A, M), E 2461, *Ratibida columnifera* (Nutt.) Wooton & Standl., E 2374, 2397, 2405, 2424, 2548; *Tetragonotheca texana* A. Gray & Engelm., E 2423, 2528, 2846; *Tetraneuris linearifolia* (Hook.) Greene, (A), E 2530; *Thymophylla micropoides* (DC.) Strother, (A), E 1987, 2431, 2460, 2939, 3102; *T. pentachaeta* (DC.) Small var. *belenidium* (DC.) Strother, E 1949, 2744, 2914, 3020; *Viguiera dentata* (Cav.) Spreng., (M) E 1571; *V. stelonoba* S.F. Blake, E 2493, 3116.

Bixaceae: *Amoreuxia wrightii* A. Gray, E 1947, 2399, 2583.

Boraginaceae: *Heliotropium confertifolium* (Torr.) Torr. ex A. Gray, E 1919, 1985, 2479, 2614, 2649; *H. torreyi* I.M. Johnst., E 2433; *Tiquilia canescens* (DC.) A.T. Richardson, E 1974, 2923, 3072.

Brassicaceae: *Lepidium virginicum* L., (A, M), E 2821, 3084; *Physaria fendleri* (A. Gray) O'Kane & Al-Shehbaz, E 2499, 2697, 3087; *Nerisyrenia incana* Rollins, E 2541.

Cactaceae: *Cylindropuntia leptocaulis* (DC.) F.M. Knuth, E 2963; *Echinocactus texensis* Hopffer; *Echinocereus poselgeri* Lem.; *E. stramineus* (Engelm.) F. Seitz; *Mammillaria heyderi* Muehlenpf.; *Opuntia lindheimeri* Engelm., E 2959; *Sclerocactus scheeri* (Salm-Dyck) N.P. Taylor.

Cleomaceae: *Polanisia uniglandulosa* (Cav.) DC., (A, M), E 1597, 2401, 2535, 2578.

Celastraceae: *Schaefferia cuneifolia* A. Gray, E 2610, 2936, 3026, 3110.

Convolvulaceae: *Ipomoea costellata* Torr., (A), E 2651.

Cucurbitaceae: *Apodanthera undulata* A. Gray, (M); *Ibervillea tenuisecta* (A. Gray) Small, E 1969, 2526, 2604, 2928.

Euphorbiaceae: *Argythamnia humilis* (Engelm. & A. Gray) Müll. Arg., E 2426, 2534, 2898; *Croton incanus* Kunth, E 1629, 1924, 2414; *C. monanthogynus* Michx., (A), E 2442; *C. pottsii* (Klotzsch) Müll. Arg., E 2585; *Euphorbia johnstonii* Mayfield, E 2432; *E. nutans* Lag., (A, M), E 2570, 2577; *E. prostrata* Aiton (A), E 2881, 2994; *Jatropha cathartica* Terán & Berland.; *J. dioica* Cerv., E 2946; *Phyllanthus polygonoides* Nutt. ex Spreng., E 2404, 2511, 3019.

Fabaceae: *Acacia constricta* Benth., E 2740; *A. greggii* A. Gray, E 2354, 2445, 2542, 3078; *A. rigidula* Benth., E 3098; *Calliandra conferta* Benth., E 1933, 2495, 3101; *Cercidium texanum* A. Gray, E 1961, 2927, 3107; *Dalea aurea* Nutt. ex Pursh, E 2398; *D. pogonathera* A. Gray var. *pogonathera*, E 1977, 2386, 2459, 2482, 2527, 2897, 3006, 3086; *Desmanthus virgatus* (L.) Willd., (M), E 2381, 2586, 2654, 2743; *Eysenhardtia texana* Scheele, E 1962, 2413, 2438; *Mimosa turneri* Barneby, E 1918; *M. unipinnata* D.B. Parfitt & Pinkava, E 2407; *Prosopis glandulosa* Torr. var. *glandulosa*, E 2794, 2957, 3031.

Hydrophyllaceae: *Nama hispida* A. Gray, E 2370, 2835.

Lamiaceae: *Salvia ballotiflora* Benth., E 1630, 1929, 3013, *Scutellaria potosina* Brandegee, E 2357, *S. microphylla* Moc. & Sessé ex Benth., E 2371.

Malvaceae: *Abutilon wrightii* A. Gray, E 2415; *Herissantia crispa* (L.) Brizicky, (M) E 1644, 1931, 2458, 2480, 2933, 2942; *Hibiscus coulteri* Harv. ex A. Gray, E 1988, 2467, 2573, 2903; *Malvastrum coromandelianum* (L.) Garcke, (M), E 2394; *Malvella sagittifolia* (A. Gray) Fryxell, E 2360; *Sida abutifolia* Mill., (M), E 1937, 2454, 2529, 2734; *Sphaeralcea angustifolia* (Cav.) G. Don, (M), E 2882, 2974, 2993; *S. hastulata* A. Gray, (M), E 2584.

Oleaceae: *Forestiera angustifolia* Torr.

Phytolaccaceae: *Rivina humilis* L., E 2490.

Portulacaceae: *Portulaca pilosa* L., (A, M), E 2636, 2918, 3081

Rhamnaceae: *Karwinskia humboldtiana* (Schult.) Zucc., E 1960, 2373, 2543, 2552, 2666, 2937, 3015, 3113; *Ziziphus obtusifolia* (Hook. ex Torr. & A. Gray) A. Gray.

Rubiaceae: *Hedyotis nigricans* (Lam.) Fosberg, E 2532.

Rutaceae: *Thamnosma texanum* (A. Gray) Torr., E 2469, 2567, 2647, 2943.

Scrophulariaceae: *Leucophyllum frutescens* (Berland.) I.M. Johnst., E 1587, 1917, 2491, 2571, 3001.

Simaroubaceae: *Castela erecta* Turpin subsp. *texana* (Torr. & A. Gray) Cronquist, E 2652, 2926, 2965, 2989, 3039, 3109.

Solanaceae: *Chamaesaracha crenata* Rydb., E 2380, 2694; *Quincula lobata* (Torr.) Raf., E 2379, 2569; *Solanum elaeagnifolium* Cav., (M) E 2657, 2813.

Talinaceae: *Talinum aurantiacum* Engelm., E 2366, 2566, 3010, 3029.

Verbenaceae: *Aloysia gratissima* (Gillies & Hook.) Tronc., E 1965, 2355, 2589, 2689, 3032; *Citharexylum brachyanthum* (A. Gray ex Hemsl.) A. Gray, E 1963, 1972, 2609, 2615, 2615, 2935; *Glandularia bipinnatifida* (Nutt.) Nutt., (A, M), E 2671, 2831, 3095; *G. delticola* (Small) Umber, (A), E 2489; *Lantana camara* L., E 1627, 1973, 2565, 2804; *L. macropoda* Torr., E 1564, 1626, 1966, 2392, 2608a, 3002; *Lippia graveolens* Kunth, E 1625, 1928, 1964, 2412, 2434, 2440, 2492, 2524, 2594; *Verbena neomexicana* (A. Gray) Briq., E 2356, 2531, 2682.

Zygophyllaceae: *Guaiacum angustifolium* Engelm., E 2421, 2538, 2954, 3041; *Larrea tridentata* (Sessé & Moc. ex DC.) Coville, E 2687, 2795, 2944.

MONOCOTYLEDONEAE (LILIOPSIDA)

Asparagaceae: *Yucca treculeana* Carrière

Amaryllidaceae: *Cooperia drummondii* Herb., E 3008.

Commelinaceae: *Aneilema karwinskiana* Woodson, E 2579, 2638, 2741; *Commelina erecta* L. var. *angustifolia* (Michx.) Fernald, E 2418.

Poaceae: *Aristida purpurea* Nutt. var. *purpurea*, E 1981, 2637; *Bouteloua trifida* Thurb., E 1980, 2435, 2599, 2653; *Digitaria californica* (Benth.) Henrard, E 1978, 3017; *Dinebra panicea* (Retz.) Ohwi subsp. *mucronata* (Michx.) P.M. Peterson & N. Snow, E 2568, 2581; *Hilaria mutica* (Buckley) Benth., E 1946, 1975, 2402, 2439, 2533, 2582; *Panicum hallii* Vasey var. *hallii*, E 1970, 2419, 2682; *Pappophorum bicolor* E. Fourn., E 1955, 2909, 2948; *Tridens texanus* (S. Watson) Nash, E 2400, 2420, 2580; *Urochloa fasciculata* (Sw.) R.D. Webster, (A, M), E 1959, 2395, 2453, 2596, 2990, 3089.

AGRADECIMIENTOS

Estamos agradecidos con el herbario ANSM por las facilidades para la consulta e identificación de especies registradas en esta investigación. Se agradece a dos revisores anónimos quienes aportaron valiosos comen-

tarios a la primera versión. Efrén Mata Rocha apoyó en la toma de datos y captura de la información de campo. Agradecemos a Felipe N. Hernández Soto la elaboración de la figura 1.

REFERENCIAS

Amodeo, M.R. & S.M. Zalba. 2013. Wild cherries invading natural grasslands: unraveling colonization history from population structure and spatial patterns. Pl. Ecol. 214(11):1299–1307.

Andrade, G.M., G. Calderón de Rzedowski, S.L. Camargo-Ricalde, R. Grether, H.M. Hernández, A. Martínez-Bernal, L. Rico, J. Rzedowski, & M. Sousa S. 2007. Flora del Bajío y regiones adyacentes. Familia Leguminosae subfamilia Mimosoideae. Fascículo 150. Instituto de Ecología, A.C. Pátzcuaro, Michoacán, Mexico.

Baruch, Z., A.B. Hernández, & M.G. Montilla. 1989. Dinámica del crecimiento, fenología y repartición de biomasa de gramíneas nativas e introducidas en una sabana neotropical. Ecotropicos 2:1–13.

Briones, O. & J.A. Villarreal. 2001. Vegetación y flora de un ecotono entre las provincias del Altiplano y de la Planicie Costera del Noreste de México. Acta Bot. Mex. 55:39–67.

Buckman, H. & N. Brady. 1970. Naturaleza y propiedades de los suelos. Editorial Montaner y Simón S.A. Barcelona, España.

Calderón de Rzedowski, G. 1994. Flora del Bajío y regiones adyacentes. Familia Cochlospermaceae. Fascículo 28. Instituto de Ecología, A.C.

Comisión Nacional para el Conocimiento y Uso de la Biodiversidad (CONABIO). 2014. Malezas de México. http://www.conabio.gob.mx/malezasdemexico/2inicio/paginas/lista-plantas-generos.htm [accessed Julio 2014].

Estrada, C.E. & A. Martínez. 2003. Los géneros de leguminosas del norte de México. Sida, Bot. Misc. 25:1–134.

Estrada, C.E., J.A. Villarreal, & E. Jurado Y. 2005. Leguminosas del norte del estado de Nuevo León, México. Acta Bot. Mex. 73:1–18.

Estrada, C.E., L. Scott-Morales, J.A. Villarreal-Quintanilla, E. Jurado-Ybarra, M. Cotera-Correa, C. Cantú-Ayala, & J. García-Pérez. 2010. Clasificación de los pastizales halófilos del noreste de México asociados con perrito de las praderas (*Cynomys mexicanus*): diversidad y endemismo de especies. Rev. Mex. Biodivers. 81:401–416.

Food and agriculture organization of the united nations (fao). 2007. Base referencial mundial del recurso suelo. Primera actualización 2007. Informes sobre recursos mundiales de suelos No. 103. Roma, Italia.

García, E. 1973. Modificaciones al sistema de clasificación climática de Koeppen. Segunda edición. Instituto de Geografía. Universidad Nacional Autónoma de México. México, D.F. 246 p

Gentry, H.S. 1957. Los pastizales de Durango, estudio ecológico, fisiográfico y florístico. Instituto Mexicano de Recursos Naturales Renovables, A.C. México, D.F.

Golubov, J., M.C. Mandujano, & L.E. Eguiarte. 2001. The paradox of mesquites (*Prosopis* spp.): invading species or biodiversity enhancers? Bol. Soc. Bot. Méx. 69:23–30.

Gómez-Sánchez, M., A.L. Suárez-Martínez, & E.I. Martínez-Montes. 2011. Análisis florístico de un pastizal del estado de Querétaro, México. J. Bot. Res. Inst. Texas 5(2):707–717.

González E., S., M. González E., & M.A. Márquez L. 2007. Vegetación y ecorregiones de Durango. Ed. Plaza y Valdez editores. México, D.F.

Guzmán, U., S. Arias, & P. Dávila. 2003. Catálogo de cactáceas mexicanas. Universidad Nacional Autónoma de México-Comisión Nacional para el Conocimiento y Uso de la Biodiversidad. México, D.F.

Halpern, C.B., J.A. Antos, J.M. Rice, R.D. Haugo, & N.L. Lang. 2010. Tree invasion of a montane meadow complex: Temporal trends, spatial patterns, and biotic interactions. J. Veg. Sci. 21(4):717–732.

Hannah, L., J.I. Carr, & A. Lankerani. 1995. Human disturbance and natural habitat: A biome level analysis of a global data set. Biodivers. & Conservation 4:128–155.

Harker, M., L.A. García R., & M.E. Riojas-López. 2008. Composición florística de cuatro hábitats en el rancho Las Papas de Arriba, municipio de Ojuelos de Jalisco, Jalisco, México. Acta Bot. Mex. 85:1–29.

Hatch, S.L., K.N. Gandhi, & L.E. Brown. 1990. Checklist of the vascular plants of Texas. MP-1665, Texas Agric. Exp. Station, Texas A&M Univ. College Station, Texas, U.S.A.

Henrickson, J. & M.C. Johnston. 1986. Vegetation and community types of the Chihuahuan Desert. In: Barlow, J.C., Powell, A.M. & B.N. Timmermann, eds. Second Symposium on Resources of the Chihuahuan Desert Region, United States and México. Chihuahuan Desert Research Institute. Alpine, Texas, U.S.A. Pp. 20–39.

Hobbs, R.J. & L.F. Huenneke. 1992. Disturbance, diversity and invasion: Implications for conservation. Conservation Biol. 6:324–337.

Holmgren, P.C. & N.H. Holmgren. 1990. Index herbariorum, edition 8, part 1. The New York Botanical Garden, New York, U.S.A.

Instituto Coahuilense de Ecología (ICE). 2001. Ordenamiento ecológico de Coahuila, México. Gobierno de Coahuila. Saltillo, México.

Kahmen, S., P. Poschlod, & K.F. Schreiber. 2002. Conservation management of calcareous grasslands: changes in plant species composition and response of functional traits during 25 years. Biol. Conservation 104:319–328.

Magurran, A.E. 2004. Measuring biological diversity. Blackwell Science, Oxford, U.K.

Margalef, R. 1972. Homage to Evelyn Hutchinson, or why is there an upper limit to diversity. Trans. Connect. Acad. Arts Sci. 44:211–235.

Mata, R.E. 2010. Estructura, diversidad y aspectos ecológicos del matorral xerófilo en una zona de transición florística del centro-este de Coahuila, México. Tesis de licenciatura, Universidad Autónoma Agraria Antonio Narro. Saltillo, Coahuila, México.

Muller, C.H. 1947. Vegetation and climate in Coahuila. Madroño 9:33–57.

Mueller-Dombois, D. & H. Ellenberg. 1974. Aims and methods of vegetation ecology. John Wiley & Sons. Inc. New York, U.S.A.

Nai-Bregaglio, M., E. Pucheta, & M. Cabido. 2002. El efecto del pastoreo sobre la diversidad florística y estructural en pastizales de montaña del centro de Argentina. Revista Chilena Hist. Nat. 75:613–623.

Pausas, J.G. & M.P. Austin. 2001. Patterns of plant species richness in relation to different environments: An appraisal. J. Veg. Sci. 12:153–166.

Pielou, E.C. 1966. The measurement of diversity in different types of biological collections. J. Theor. Biol. 13:131–144.

Pinkava, D.J. 1984. Vegetation and flora of the Bolsón of Cuatro Ciénegas region, Coahuila, Mexico: IV. Summary, endemism and corrected catalogue. J. Arizona-Nevada Acad. Sci. 19:23–47.

Rabinowitz, D, S. Cairns, & T. Dillon. 1986. Seven forms of rarity and their frequency in the flora of the British Isles. In: M.E. Soule, ed. Conservation biology: The science of scarcity and diversity. Sinauer, Sunderland, Massachusetts, U.S.A.

Rice, J., C. Halpern, J. Antos, & J. Jones. 2012. Spatio-temporal patterns of tree establishment are indicative of biotic interactions during early invasion of a montane meadow. Pl. Ecol. 213(4):555–568.

Richardson, D.M., P. Pyšek, M. Rejmánek, M.G. Barbour, F.D. Panneta, & C.J. West. 2000. Naturalization and invasion of alien plants: Concepts and definitions. Diversity & Distrib. 6:93–107.

Rzedowski, J. 1965. Relaciones geográficas y posibles orígenes de la flora de México. Bol. Soc. Bot. Méx. 29:121–177.

Rzedowski, J. 1966. Vegetación del Estado de San Luis Potosí. Acta Ci. Potos. 5:5–291.

Rzedowski, J. 1975. An ecological and phytogeographical analysis of the grasslands of Mexico. Taxon 24:67–80.

Rzedowski, J. 1992. Diversidad y orígenes de la flora fanerogámica de México. en: G. Halffter (compilador). La diversidad biológica de Iberoamérica I. Acta Zoológica Mexicana. Volumen especial. Instituto de Ecología, A.C. Xalapa.

Rzedowski, J. 2006. Vegetación de México. 1era. Edición digital, Comisión Nacional para el Conocimiento y Uso de la Biodiversidad, México.

Rzedowski, J. & G. Calderón de Rzedowski. 1995. Los pastizales calcifilos del estado de Guanajuato. Flora del Bajío y Regiones Adyacentes 9:1–19.

Sánchez, Z., L. Serrano, O. Peñuelas, E. Pérez, E. Sequeiros, & M. García. 2007. Composición florística y estructura de la comunidad vegetal del límite del Desierto de Sonora y la Selva Baja Caducifolia. Revista Latino-Amer. Recurs. Nat. 3(1):74–83.

Secretaría de Medio Ambiente y Recursos Naturales (SEMARNAT). 2010. Norma Oficial Mexicana NOM-059-SEMARNAT-2010. Protección ambiental-Especies nativas de México de flora y fauna silvestres-Categorías de riesgo y especificaciones para su inclusión, exclusión o cambio-Lista de especies en riesgo. Diario Oficial de la Federación, 30 de Diciembre 2010. México, D.F.

Sternberg, M., M. Gutman, A. Perevolotsky, E.D. Ungar, & J. Kigel. 2000. Vegetation response to grazing management in a Mediterranean herbaceous community: a functional group approach. J. Appl. Ecol. 37:224–237.

Shreve, F. 1942. Grassland and related vegetation in northern Mexico. Madroño 6:190–198.

Taylor, R.B, J. Rutledge, & J.G. Herrera. 1999. A field guide to common south Texas shrubs. Texas Parks and Wildlife Press, Wildlife Division. Austin, Texas, U.S.A.

Vega-Mares. J.H., A.E. Estrada-Castillon, J.A. Villarreal-Quintanilla, & G. Quintana M. 2014. Flora of the halophytic grasslands in the valle de Janos, Chihuahua, Mexico. J. Bot. Res. Inst. Texas 8(1):151–163.

Villarreal, J.A. 2001. Listados florísticos de México. XXIII. Flora de Coahuila. Instituto de Biología, Universidad Nacional Autónoma de México. México, D.F.

Villarreal, J.A. & J. Valdés R. 1992–93. Vegetación de Coahuila, México. Rev. Manejo Pastizales 6(1,2):9–18.

Villarreal, J.A. & J.A. Encina. 2005. Plantas vasculares endémicas de Coahuila y algunas áreas adyacentes, México. Acta Bot. Mex. 70:1–46.

Villaseñor, J.L. 1993. La familia Asteraceae en México. Rev. Soc. Mex. Hist. Nat. Vol. Esp. (44):117–124.

JARILLA CHOCOLA (CARICACEAE), UN NUEVO GÉNERO Y ESPECIE PARA LA FLORA DE EL SALVADOR

Frank Sullyvan Cardoza Ruiz

Consultor independiente
Magister of Scientiae en Manejo y Conservación de Bosques Tropicales y Biodiversidad
Centro Tropical Agronómico de Investigación y Enseñanza (CATIE)
San Salvador, EL SALVADOR
fscardoza11@gmail.com

José Ledis Linares

Catedrático de botánica
Centro Universitario Regional del Litoral Atlántico (CURLA)
Universidad Nacional Autónoma de Honduras (UNAH)
La Ceiba, HONDURAS
linaresj_98@yahoo.com

Ana Eugenia Aguilar Grijalva

Bióloga, Universidad de El Salvador (UES)
Ministerio de Medio Ambiente y Recursos Naturales (MARN)
San Salvador, EL SALVADOR
aeugenia_bio@yahoo.com

RESUMEN

Se reporta la especie *Jarilla chocola* Standl. (Caricaceae) que constituye el primer registro del género para El Salvador. Las localidades de colecta se convierten en las más orientales para todo el género, conocido sólo de México y Guatemala; representando una importante e interesante adición a la flora salvadoreña. Se describe el género tal como ocurre en el país y se ilustra fotográficamente por primera vez la especie. Asimismo, se presenta información ecológica de las localidades donde se ha encontrado el género hasta ahora en El Salvador.

PALABRAS CLAVE: El Salvador, Caricaceae, *Jarilla chocola*, distribución, México

ABSTRACT

Jarilla chocola Standl. (Caricaceae) is reported new to the flora of El Salvador. The collection localities represent the easternmost known collections from Mexico and Guatemala, and represent an important and exciting addition to the Salvadoran flora. *Jarilla chocola* is described in detail along with ecological and habitat information and photographs are provided.

KEY WORDS: El Salvador, Caricaceae, *Jarilla chocola*, distribution, Mexico

INTRODUCCIÓN

El Salvador, ha sido durante mucho tiempo el país más pobremente colectado de la región Centroamericana y probablemente sea el más desconocido en el aspecto florístico. Esto ha generado un importante atraso con respecto a los demás países vecinos, siendo el más pequeño (21,040.79 kilómetros cuadrados), el más densamente poblado (6.3 millones de habitantes) y probablemente el más deforestado del hemisferio después de Haití; siendo esto, la falta de interés para investigadores de otros países que prefieren concentrar sus esfuerzos en áreas relativamente bien conservadas con abundante vegetación (Linares 2003). En un área tan pequeña, la demanda por recursos se hace cada vez más prioritaria y la presión sobre los mismos más crítica, manifestándose en el deterioro de los ecosistemas, pérdida de biodiversidad y altos niveles de contaminación en sus recursos (MARN 2005).

Los bosques primarios han desaparecido casi totalmente y en la franja costera todavía quedan restos de la antigua selva tropical, con áreas de mangles que en algunos casos el deterioro por actividades agrícolas y deforestación es evidente. Sin embargo, debido a lo accidentado del relieve y a la continua actividad volcánica, subsisten en todo el territorio pequeñas áreas o relictos donde aún sobrevive algún tipo de vegetación y en donde se desarrollan diferentes etapas de sucesión, encontrándose generalmente en pendientes escarpadas o en recientes campos de lava y la presión del hombre, sobre ellas, es relativamente pequeña (Linares 2003). A pesar

de esta problemática ambiental y el limitado territorio, existe una considerable riqueza en los ecosistemas por su posición geográfica, latitudinal, historia geológica y su compleja topografía (MARN 2005).

Género Jarilla

El género *Jarilla* de la familia Caricaceae, fue descrito por primera vez en 1832 por La Llave bajo el nombre de *Mocinna*. Desde la publicación inicial del género se han descrito diferentes especies, subespecies y variedades, todas las cuales fueron posteriormente concentradas en un sólo taxón, *Jarilla heterophylla* Rusby. Sin embargo, es un género de taxonomía complicada; porque algunos autores sólo reconocían una especie variable, mientras que otros distinguen tres: *J. caudata*, *J. chocola*, *J. heterophylla* y un híbrido natural: *J. caudata* × *J. heterophylla*. Estas especies se desarrollan en los bosques caducifolios de México y Guatemala (Romero 2013). *Jarilla*, está distribuida principalmente en México, con una especie (*J. chocola*) que se extiende hasta Guatemala (Díaz & Lomeli 1992).

DESCRIPCIÓN DE LA ESPECIE

Jarilla chocola Standl. Field Mus. Nat. Hist., Bot. Ser. 17(2):200. 1937. (**Fig. 1**). TIPO: MÉXICO: CHIHUAHUA: Guasaremos, Río Mayo, 10 Aug 1936, *Howard Scott Gentry 2366* (HOLOTYPE: F).

Ilustraciones.—Díaz Luna y Lomelí Sención, Acta Bot. Mex. 20:85, t. 3, 1992.

Plantas erguidas de 20–50 cm de alto, generalmente sin ramificaciones. Tubérculos fusiformes de cerca de 10 cm, ocasionalmente 20 cm de longitud. Tallo aéreo verde de 1–8 mm de diámetro, suculento, generalmente glabro. Hojas con un pecíolo de 3–20 cm de longitud y de 0.5–4 mm de diámetro, con presencia de látex en la base del pecíolo. Limbo glabro, de 5–17.5 cm de longitud y de 5–18.3 cm en su parte más ancha, generalmente más ancho que largo, de color verde oscuro en el haz y más claro en el envés, generalmente 3–5 lobulado, bordes lisos, los lóbulos pueden ser insinuados o profundamente hendidos, a veces subdivididos, de ápice agudo, redondeado o acuminado, con salientes pronunciadas o dientes. Base truncada, cóncava, obtusa, cordada, redondeada o bilobulada, a veces con salientes hasta de 2 cm de largo. Borde entero o con salientes aristadas, hendido con lóbulos redondeados o agudos. Ápice acuminado o caudado. Con 3–5 nervaduras basales, que generalmente terminan en los lóbulos.

Inflorescencias masculinas con 8–40 flores en un pedúnculo de 6.8–20.5 cm de longitud, filiforme o hasta de 3 mm de diámetro. Flor masculina con el cáliz de 0.4–1.3 mm de largo, los segmentos elípticos de ápice agudo. Corola de color blanco de 5.1–8.6 mm de largo, tubo de 2.3–4.8 mm de largo, con lóbulos de aproximadamente la misma longitud, de 1.3–1.7 mm de ancho y ápice redondeado. Estambres del grupo superior con anteras de 1.4–1.8 mm de largo y filamentos de 1.2–1.4 mm de longitud; el grupo inferior con anteras de 1.8–1.9 mm de largo y filamentos de 0.3–0.7 mm de longitud. Rudimento del ovario de 3 mm de largo.

Flores femeninas solitarias, sobre un pedúnculo filiforme de 8–23 mm de largo. Cáliz con segmentos triangulares de ápice agudo, de aproximadamente 1.4 mm de largo, alternos a los segmentos corolinos. Corola con lóbulos largamente elípticos de ápice redondeado, de 8–9 mm de largo y de 2–3 mm de ancho. Ovario de forma ascoide con base truncada, presenta exteriormente cinco alas longitudinales prolongadas cada una en un apéndice basal, alternándose con una sutura interalar; estigmas densamente papilosos, de forma sigmoide, de 2.2–2.9 mm de largo por 0.4 mm de diámetro (Fig. 2)

Frutos solitarios en un pedúnculo de 0.2–3.2 cm de longitud; globosos-alargados, ascoides u ovoides, de color verde uniforme, de 2.3–7 cm de longitud total y de 1.6–4 cm de diámetro en su parte media; su porción basal truncada o cóncava, sin cuello; presenta cinco alas longitudinales de 9 mm de alto que se prolongan en la base en cinco apéndices de 4–9 mm de longitud; su porción apical redondeada, prolongándose en un apéndice de 3–5 mm de longitud en donde convergen las alas y las suturas intercalares (Fig. 3). Con 40–100 semillas por fruto. Semillas de 3.2–5 mm de largo con testa de color negro o pardo claro, superficie casi lisa con granulaciones y surcos semireticulados más obscuros ligeramente hendidos, porción anterior aguda, observándose en su cara ventral un arilo alargado de color claro y sabor agridulce con olor afrutado ácido.

Hábitat.—Está asociado a bosque tropical deciduo y subdeciduo, bosque de encino, matorral xerófilo, pastizal y formas perturbadas de estos tipos de vegetación, en altitudes que van de 330 a 2,700 msnm. En estos

Fig. 1. *Jarilla chocola* Standl. **A.** Planta completa en su hábitat natural; **B.** Flores; **C.** Botones; **D.** Látex. Fotos: Frank Sullyvan Cardoza.

ecosistemas es donde se encuentra una diversidad muy apreciable que posee especies aún no registradas para El Salvador como el caso de *Jarilla chocola*. Esta especie herbácea perenne es un habitante inconspicuo de estos tipos de bosques y probablemente debido a su porte pequeño, su floración efímera y al hecho de perder toda la parte aérea durante gran parte del año, ha pasada desapercibida durante largo tiempo. Además, estos tipos de bosque han sido relativamente poco colectados en el país y en muchos casos son considerados como de poca diversidad e importancia. En El Salvador, el género crece en selvas bajas caducifolias, asociadas a antiguos campos de lava en grandes acumulaciones de humus y en una pequeña franjas de vegetación de transición entre la selva baja y el bosque de robles (*Quercus* spp.). Estos bosques tienen una estación seca muy fuerte con escasas precipitaciones. La distribución altitudinal varía desde los 250 hasta los 800 msnm.

Fenología.—El tallo aéreo generalmente emerge a principios de junio; florece desde principios de julio hasta fines de agosto (Fig. 3); fructificación, mediados de julio hasta fines de septiembre (Díaz & Lomeli 1992). En El Salvador los tallos emergen muy a principio de la temporada lluviosa (principios de mayo) y la floración se observa en las primeras semanas de abril y fructificación es en junio del siguiente año.

Material examinado.—**EL SALVADOR. Santa Ana:** Municipio Texistepeque, Cantón Valle Nuevo. Localidad: Cerros Pedregosos de Valle Nuevo, 4 km al S de Texistepeque, 14°05'26.54"N, 89°30'25.14"W, 10 Ago 2009, *J.L. Linares y C.A. Martínez 13882* (MEXU); Municipio Texistepeque, Cantón Cujucuyo, Caserío Valle Nuevo, Aproximadamente 14 km al nor-este de la ciudad de Santa Ana en carretera CA-12 hacia Metapán, cerca de entrada principal al Cantón Cujucuyo. Coordenadas 14°05'25"N y 89°30'15"W, vegetación bosque tropical semideciduo en zona perturbada en áreas de potreros a una altitud 450 msnm, 2 Jun 2013, *J.L. Linares, Frank Sullyvan Cardoza y A. Eugenia Aguilar 15,025* (MEXU); Municipio de Metapán, Aproximadamente 4.5 km al sur-este de la ciudad de Metapán en carretera CA-12 (Alrededores de una pequeña laguna al lado oriente de la carretera a Santa Ana), coordenadas 14°17'43.76"N y 89°27'47.74"W, vegetación bosque sub-tropical semideciduo en zona de pendientes con rocas basálticas creciendo en el sotobosque entre mucha hojarasca a la sombra de *Ficus ovalis*, altitud 472 msnm, 13 Abr 2014, *J.L. Linares, Frank Sullyvan Cardoza y A. Eugenia Aguilar 16,005* (MEXU).

Etimología.—El género fue establecido en 1921 por Rusby, por el nombre común de "jarrilla" dado en el occidente de México a la especie *Jarilla heterophylla*. El epíteto chocola, probablemente aluda a algún nombre común dado en Guatemala a esta planta.

Características de la especie.—Esta especie se caracteriza por su tallo erguido, ovario y fruto con alas longitudinales y hojas generalmente palmadas, más anchas que largas. Las semillas requieren de un período de reposo para presentar germinación aceptable; la emergencia ocurre entre 10 y 17 días después de la siembra (Díaz & Lomelí 1992; Willingham & White 1976). Según Díaz & Lomeli (1992) *Jarilla chocola* crece en bosque tropical deciduo, y zonas perturbadas de estos tipos de vegetación, a una altitud de 330–1200 msnm. En El Salvador esta especie crece en selvas bajas caducifolias (bosque tropical deciduo), selvas bajas subcaducifolias (bosque tropical subdeciduo) entre 200–800 msnm y en ecotonos de bosque de pino-roble y selva baja caducifolia a una altura cercana a 1000 metros. Algunos nombres comunes son "chocola," "kapiya" (Chihuahua); "bonetillo" (Jalisco); "berenjena" (Michoacán); "papayillo" (Nayarit); "chocola," "kapiah" (Sonora); "talguento" (Guatemala). En El Salvador no se han registrado nombres, ya que ha pasado desapercibida durante mucho tiempo.

Distribución geográfica.—Se encuentra en México en los estados de Chihuahua, Sonora, Sinaloa, Nayarit, Jalisco, Michoacán y Chiapas. En Guatemala se le conoce del departamento de Jutiapa (Díaz & Lomeli 1992). En El Salvador se ha colectado en los departamentos de Ahuachapán y Santa Ana, específicamente en la parte norte del macizo del Imposible (departamento Ahuachapán) en selvas bajas junto con especies típicas de este tipo de vegetación como *Bursera simaruba*, *Spondias purpurea*, *Spondias mombim*, *Machaerium* spp. y *Combretum* spp. En el departamento de Santa Ana, se ha colectado en la parte norte en las cercanías de la Laguna de San Diego creciendo en acumulación de humus en rocas volcánicas recientes con las especies *Gyrocarpus jatrophifolius*, *G. mocinoi*, *Omphalea oleifera*, *Poeppigia procera*, *Bursera simaruba* y *Jacaratia mexicana*. En las cercanías de Candelaria de la Frontera, crece también en humus acumulado en suelos blancos probablemente originados de tobas volcánicas del terciario junto con especies características de la selva baja caducifolia. Siempre en Santa Ana, se ha encontrado en el Cantón Cujucuyo creciendo en vegetación de bosque tropical semideciduo; específicamente en zonas perturbadas en áreas de potreros a una altitud 450 msnm asociada con árboles dispersos de *Guazuma ulmifolia, Luehea candida, Spondias purpurea, Bursera simaruba, Ficus ovalis, Sapranthus*

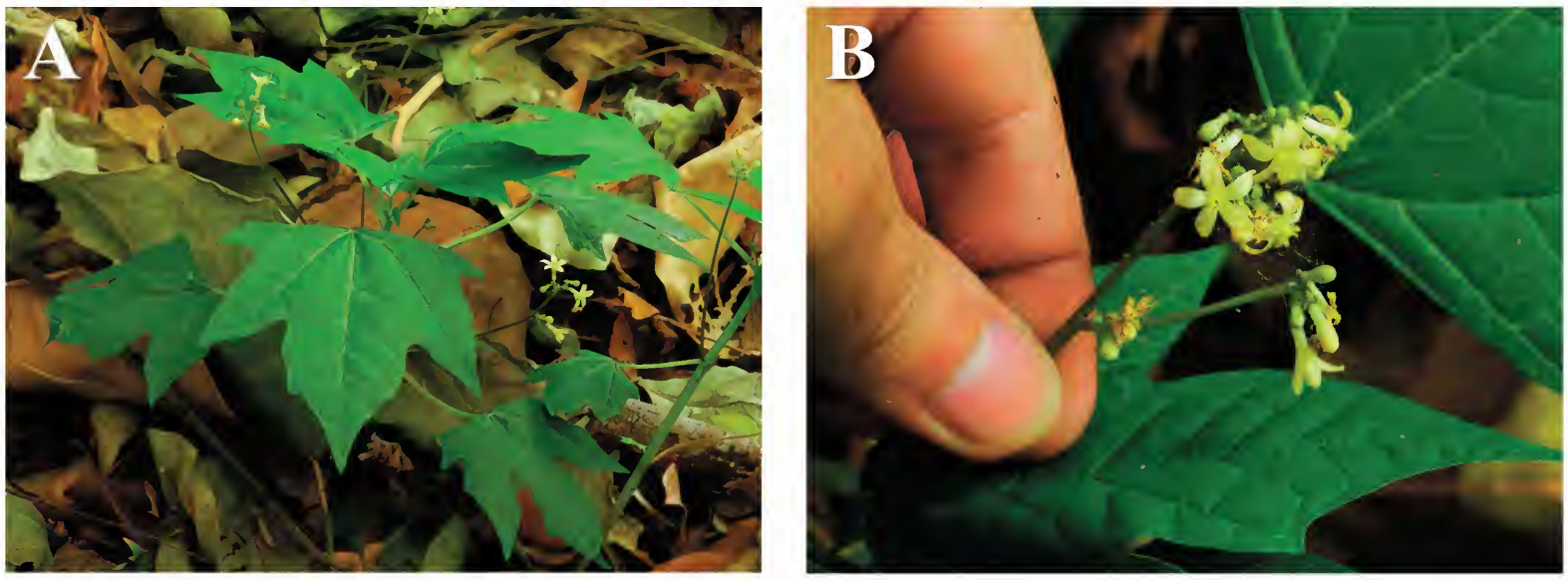


Fig. 2. *Jarilla chocola* Standl. **A.** Detalle de las hojas; **B.** Detalle de las flores e inflorescencia. Fotos: Frank Sullyvan Cardoza.

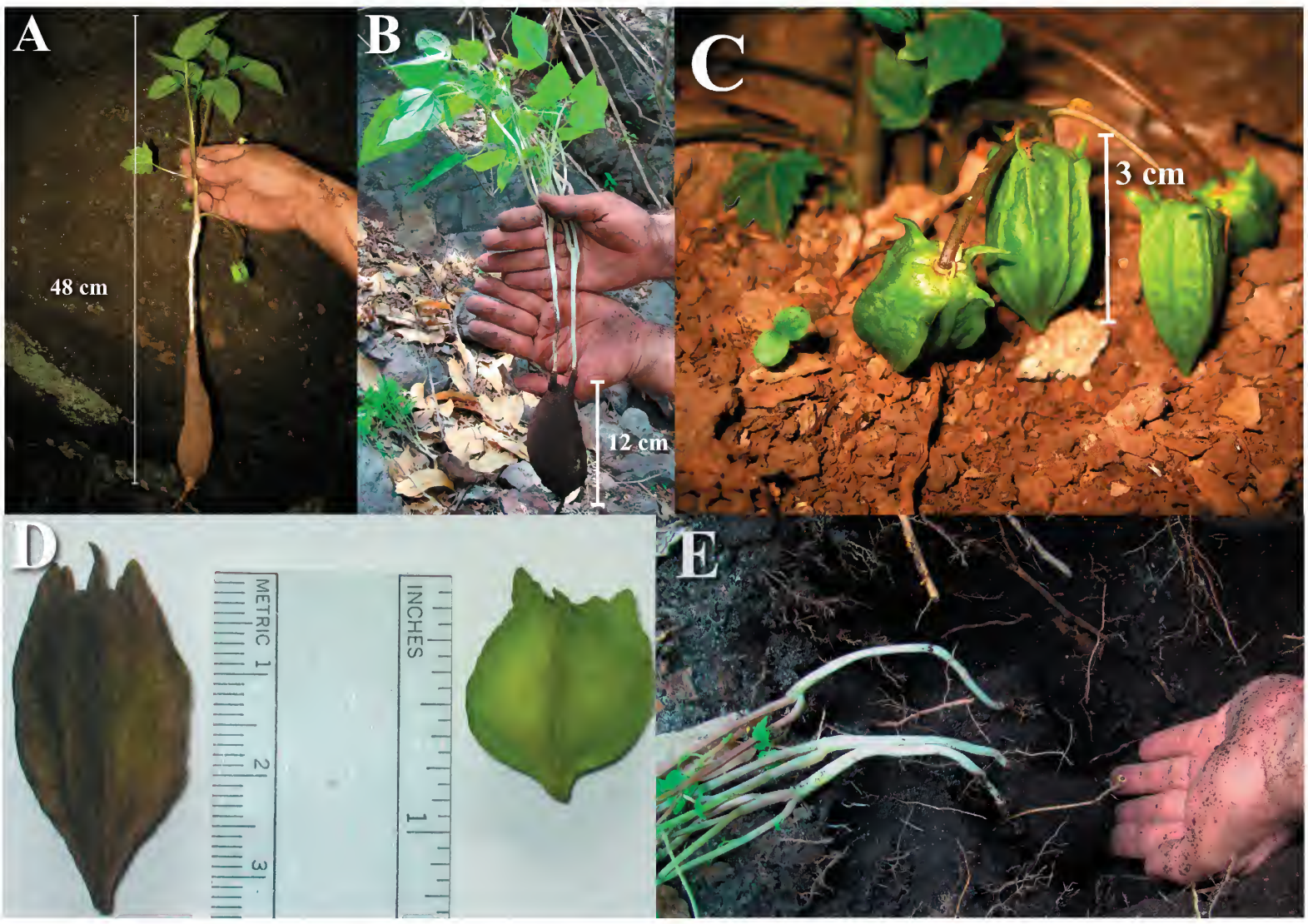


Fig. 3. *Jarilla chocola* Standl. **A.** Plantas con tubérculo y fruto; **B.** Tubérculo fusiformes con parte aérea; **C.** Detalle de los frutos; **D.** Fruto seco y verde con mediciones; **E.** Sacando tubérculo en su hábitat. Fotos: Frank Sullyvan Cardoza.

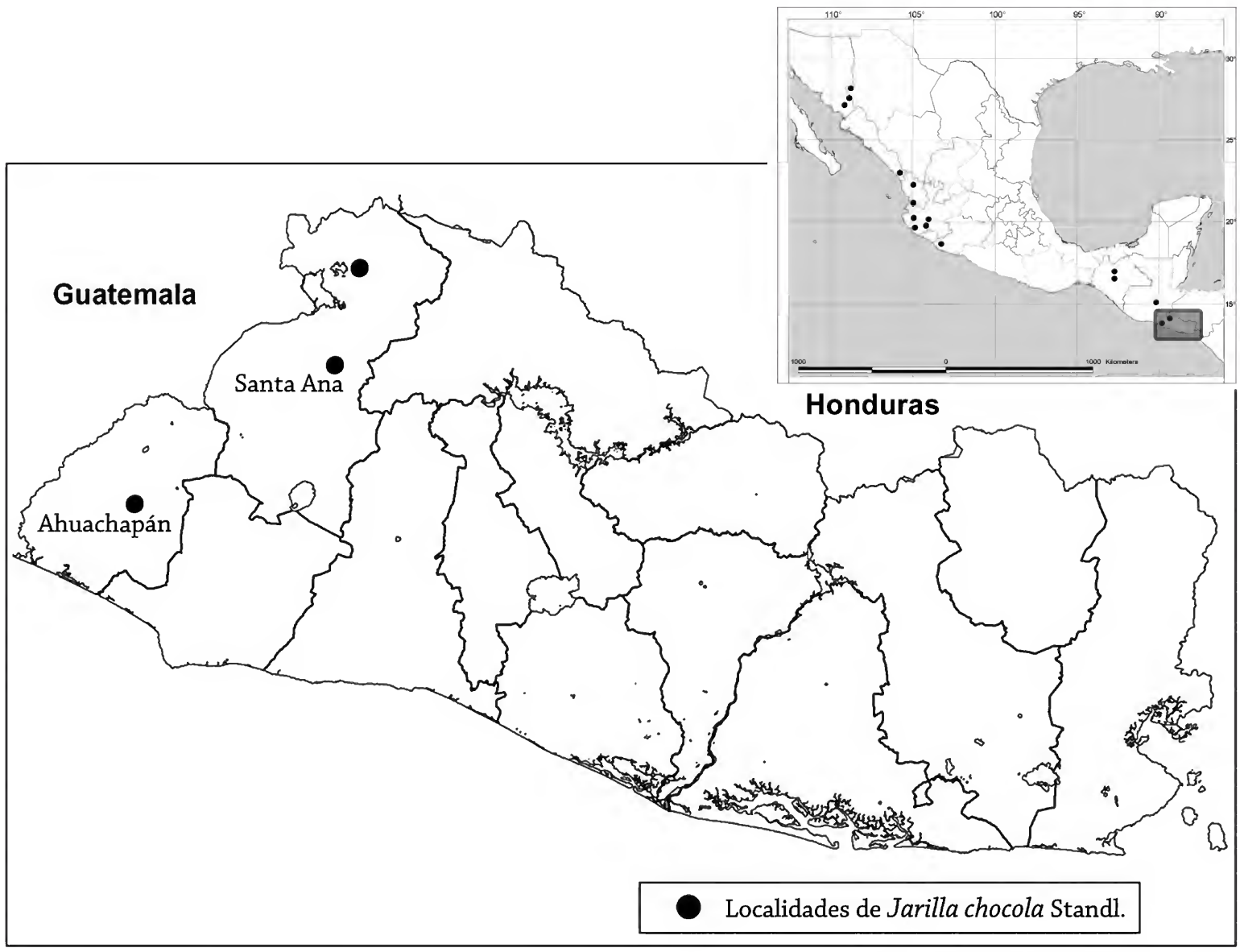


Fig. 4. Distribución geográfica y localidades en México, Guatemala y El Salvador de *Jarilla chocola* Standl.

violaceus, *Calycophyllum candidissimum*. Suelos rocosos y expuestos de tobas volcánicas con pendientes entre 25–40% (Fig. 4).

CONCLUSIONES

Esta especie es poco frecuente considerándose extinta en muchas zonas del país debido a la degradación y fragmentación de su hábitat. El Estado de acuerdo con los criterios de la Lista Roja de Especies Amenazadas (UICN 2012) y según las observaciones de los autores, encontrada en áreas de condiciones muy específicas sujetas a impactos y perturbaciones; se considera que la categoría debería ser Vulnerable, VU A1(d).

AGRADECIMIENTOS

Nuestra gratitud a los dos revisores anónimos por sus valiosos comentarios y observaciones. También a Barney Lipscomb por su valiosa revisión y apoyo en esta publicación que contribuye a la divulgación del conocimiento de la flora salvadoreña. Un sincero agradecimiento también a un revisor anónimo por sus sugerencias y comentarios.

REFERENCIAS

Díaz, C. & J. Lomeli. 1992. Revisión del Género Jarilla Rugby (Caricaceae). Acta Bot. Mex. 20:77–99.

Linares, J.L. 2003 [2005]. Listado comentado de los árboles nativos y cultivados en la república de El Salvador. Ceiba 44(2):105–268.

MARN (Ministerio de Ambiente y Recursos Naturales de El Salvador). 2005. Estado del Conocimiento de la Biodiversidad en El Salvador. MARN, San Salvador, El Salvador.

Romero, J.A. 2013. Manejo y conservación de germoplasma de la familia Caricaceae. Postgrado de Recursos Genéticos y Productividad. Colegio de Postgraduados. Campus Montecillo. Tesis para Doctor en Ciencias.

UICN (Unión Internacional para la Conservación de la Naturaleza). 2012. Categorías y criterios de la lista roja de la UICN: Versión 3.1. Segunda edición. Gland, Suiza y Cambridge, Reino Unido.

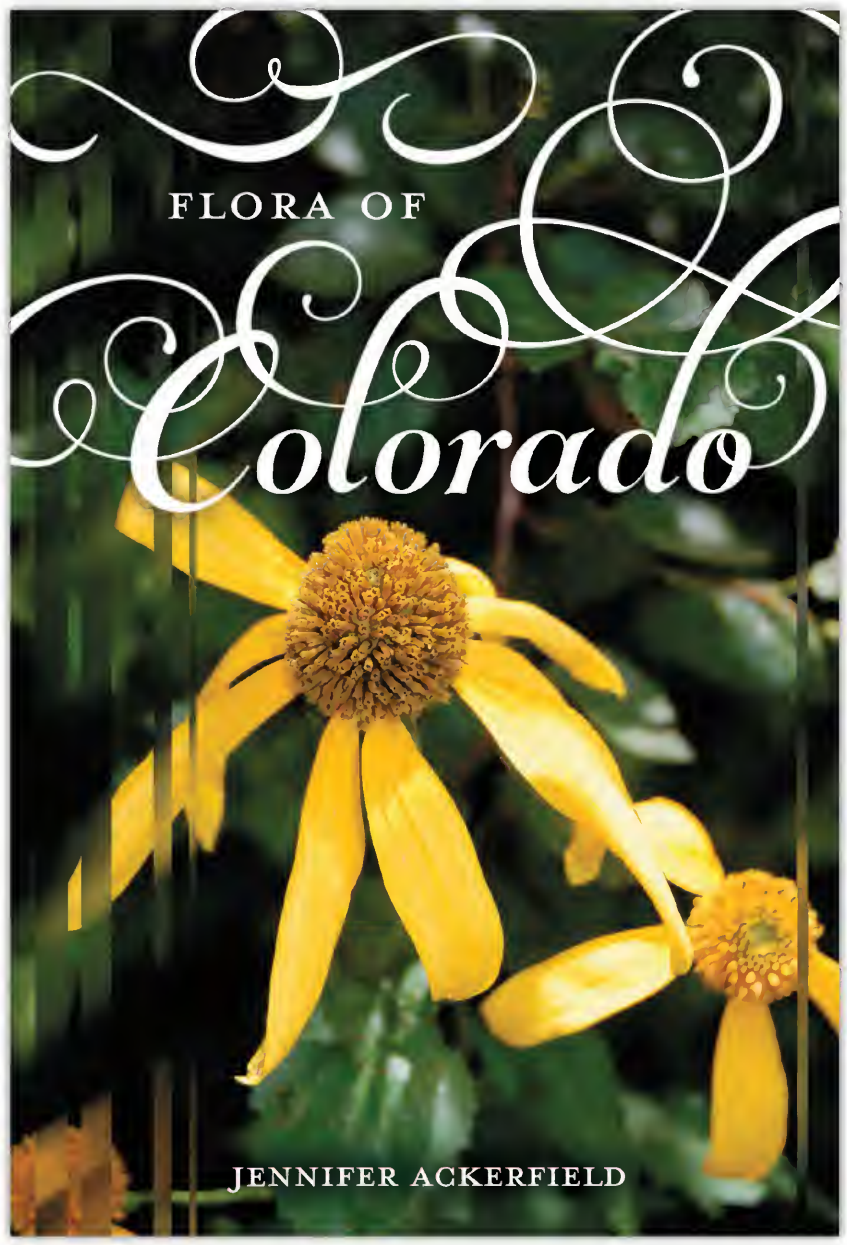
Willingham, B.C. & G.A. White. 1976. Agronomic evaluation of prospective new crop species. V. *Jarilla chocola:* A proteinase source. Econ. Bot. 30(3):189–192.

BOOK NOTICE

JENNIFER ACKERFIELD. Spring 2015. **The Flora of Colorado.** (pbk). Botanical Research Institute of Texas Press, 1700 University Drive, Fort Worth, Texas 76107 U.S.A. (**Orders:** shop.brit.org, 1-817-332-4441). $65.00, approx. 880 pp., color plates, distribution maps, 6.5" × 9.5".

From the Publisher: Colorado has a rich diversity of ecosystems and vegetation communities, ranges from 3,500 ft to over 14,000 ft in elevation, and ultimately supports over 3,300 vascular plant species. This book is a comprehensive guide to the vascular plants in Colorado, and contains descriptions, distribution maps, habitat information, flowering times, and elevation ranges for all species. Color photographs for nearly ⅓ of the species are also included. The aim of this guide is to enable students, researchers, amateur and professional botanists, or anyone interested in the flora of Colorado to successfully identify plants with confidence and satisfaction.

JENNIFER ACKERFIELD has been studying the flora of Colorado for nearly 20 years. During this time, she has traveled extensively across the state of Colorado documenting its rich floristic diversity. She is currently the collection's manager at the Colorado State University herbarium and teaches Plant Identification at CSU. She has served on the board for the Colorado Native Plant Society, and written several articles on the flora of Colorado. She enjoys hiking, photographing wildflowers, botanical illustration, and educating students on the wonderful world of botany.



REDESCUBRIMIENTO Y NUEVOS REGISTROS DE *CUSCATLANIA VULCANICOLA* (NYCTAGINACEAE) PARA EL SALVADOR

José Ledis Linares

Catedrático de botánica
Centro Universitario Regional
del Litoral Atlántico (CURLA)
Universidad Nacional Autónoma de Honduras (UNAH)
La Ceiba, HONDURAS
jose.linares@unah.edu.hn

Frank Sullyvan Cardoza Ruiz

Consultor independiente
Magister Scientiae en Manejo y Conservación
de Bosques Tropicales y Biodiversidad
Centro Tropical Agronómico
de Investigación y Enseñanza (CATIE)
San Salvador, EL SALVADOR
fscardoza11@gmail.com

Patricia Hernández-Ledesma

Departamento de Botánica, Instituto de Biología
Universidad Nacional Autónoma de México (UNAM)
México, D.F., MÉXICO
phl@ibunam2.ibiologia.unam.mx

RESUMEN

En el transcurso de varias décadas, el botánico Paul C. Standley realizó diversos tratamientos y describió una gran cantidad de especies de Nyctaginaceae; que incrementaron el conocimiento de la familia en Norte y Centroamérica, convirtiéndose en el principal especialista hasta el momento. En su expedición por El Salvador en 1922, colectó en la base del Volcán de San Vicente una peculiar nictaginácea de flores vistosas, que describió en 1923 como *Cuscatlania vulcanicola*, única especie del género que permaneció prácticamente desconocida para los taxónomos, pues sólo se conocían dos ejemplares, el holotipo y un isotipo. Se presentan por primera vez fotografías de plantas vivas de esta especie, después de 91 años de haberse publicado, considerándose extinta por no haberse reportado ni en la zona original de colecta ni en otros lugares. Sin embargo, ahora se reportan nuevos registros de otra localidad en el Occidente del país (Sonsonate), lo que representa un redescubrimiento para la flora salvadoreña. También se presenta una descripción más detallada de esta especie, haciendo algunos comentarios sobre su morfología, taxonomía y proporcionando datos de distribución y hábitat.

PALABRAS CLAVE: *Cuscatlania*, nictaginácea, redescubrimiento, Sonsonate, Standley, El Salvador

ABSTRACT

Over the course of several decades botanist Paul C. Standley worked on various taxonomic treatments and described a large number of species that increased our knowledge of the Nyctaginaceae family in North and Central America, becoming the leading specialist so far. In his expedition to El Salvador in 1922, a peculiar Nyctaginaceae with showy flowers was collected at the base of Volcan San Vicente, which he described in 1923 as *Cuscatlania vulcanicola*, which is only species of the genus and remained virtually unknown to taxonomists because only two specimens (the holotype and isotype) are known. Presented for the first time here are photographs of living plants of this species, after 91 years of being considered extinct since it has not been reported either in the original collection area or elsewhere since the original publication. But now new records of other localities in the west of the country (Sonsonate) are reported, representing a rediscovery for the Salvadoran flora. A more detailed description of this species is also presented, with some comments on the morphology, taxonomy, and distribution and habitat data.

KEY WORDS: *Cuscatlania*, rediscovery, Nyctaginaceae, Sonsonate, Standley, El Salvador

INTRODUCCIÓN

En las exploraciones y colectas botánicas que realizó Paul C. Standley (1884–1963) en Centroamérica, particularmente en marzo de 1922 en El Salvador; colectó en el Departamento de San Vicente, en la base del Volcán San Vicente, una interesante nictaginácea de flores llamativas de color rosado, siendo una nueva especie para la ciencia que describió en 1923 como *Cuscatlania vulcanicola*.

Standley realizó diversos tratamientos y describió una gran cantidad de especies de Nyctaginaceae (p. ej. Standley 1909, 1911, 1918, 1931) que incrementó el conocimiento de la familia en Norte y Centroamérica,

convirtiéndose en el principal especialista hasta el momento. Este hecho fue muy relevante para el estudio de la familia, pues además se incrementó la diversidad genérica con este nuevo descubrimiento. Hasta entonces, *Cuscatlania vulcanicola* se conocía sólo de la localidad tipo; inclusive, en la obra "Flora Salvadoreña" que Standley realizó junto con Salvador Calderón (Standley & Calderón 1941) y en la cual culminaron sus estudios en El Salvador, para la especie se menciona la misma colecta de 1922: *Standley 21678*, que corresponde al ejemplar tipo.

Estas especie permaneció durante todas estas décadas desconocida para los taxónomos, pues solamente se conocían dos ejemplares, el holotipo (Fig. 1) depositado en el United States National Herbarium (US) y el isotipo, depositado en el herbario del Missouri Botanical Garden (MO). En este artículo, presentamos una descripción más detallada y fotografías de *Cuscatlania vulcanicola* por primera vez desde su descripción en 1923; es decir, 91 años después de su publicación. Durante todo este tiempo, aparentemente nunca había sido reportada, hasta que el primer autor (José Linares) la colectó en el departamento de Sonsonate. También hacemos algunos comentarios sobre su morfología y taxonomía y proporcionamos los datos de distribución y hábitat.

El redescubrimiento

Durante los recorridos realizados por medio del Proyecto "Mejor Manejo y Conservación de Cuencas Hidrográficas Críticas" (MMCCHC), al occidente del país en los meses de diciembre de 2007 y enero 2008, Linares y Cardoza colectaron a *Cuscatlania vulcanicola* aparentemente por primera vez desde que Standley la colectó hace más de 85 años. Es así como Standley publicó en el *Journal of the Washington Academy of Science,* en 1923, la especie *Cuscatlania vulcanicola*. El ejemplar tipo se encuentra depositado en United States National Herbarium (US) con el número *21,678*. A diferencia de Standley, *Cuscatlania vulcanicola* se colectó en el departamento de Sonsonate, municipios de Izalco y Caluco, mientras que la localidad tipo es en el Departamento de San Vicente, municipio de San Vicente en el centro oriente del país; ahora estos nuevos datos son un redescubrimiento y representan nuevos registros para El Salvador, además de ampliar su área de distribución en el país. A continuación se presenta la descripción de la especie y las primeras fotografías (en su hábitat y cultivadas) después de 91 años de su publicación. Durante uno de los recorridos se encontró una población en el Área Natural Protegida de San Marcelino, específicamente en el bosque de Las Lajas (Cantón Las Lajas, Departamento de Sonsonate), probablemente con más de 30 plantas (Linares 2009). Este importante hallazgo de redescubrimiento botánico hace énfasis en la importancia de la localidad como un reservorio de plantas raras y únicas en el mundo (Fig. 2).

DESCRIPCIÓN DE LA ESPECIE

Cuscatlania vulcanicola Standl., J. Washington Acad. Sci. 13(20):437. 1923. TIPO: EL SALVADOR. DEPARTAMENTO DE SAN VICENTE: collected at 500m, in a ravine near the base of the San Vicente Volcano, Mar 1922, *Standley 21678* (HOLOTIPO: US-imagen; ISOTIPO: MO).

Hierba postrada, ascendente o decumbente, tallo pardo oscuro, brilloso, ligeramente estriado, glabro, con ramas puberulentas o vellosas hacia el ápice. Hojas distribuidas a lo largo de todo el tallo, opuestas, evidentemente de diferente tamaño las de cada par, ovadas, oblongo ovadas u oblongo-lanceoladas, glabrescentes, las hojas jóvenes pubescentes, con tricomas glandular-estipitados, septados, hialinos, distribuidos en toda la lámina y nervadura; ápice agudo, acuminado o largamente acuminado, base cuneada, asimétrica, margen entero; hojas basales 6.0–11.0 cm de largo, 3.0–4.8 cm de ancho, reduciéndose de tamaño hacia el ápice; pecíolos 1.0–3.0 cm, pubescentes en las hojas jóvenes. Inflorescencias cimosas, con flores casmógamas terminales y cleistógamas axilares, no ramificadas formando cimas compactas y densas, las inflorescencias de flores casmógamas con numerosas brácteas foliáceas verde purpúreo en el haz y purpúreas en el envés.

Flores sostenidas por 4–8 brácteas foliáceas verde purpúreas, ovadas, lanceoladas, oblanceoladas a oblongo-elípticas, 10–12 mm de largo, 2.5–5.5 mm de ancho, pubescentes, con tricomas glandular-estipitados, septados, hialinos, margen ciliado, sésiles, formando un involucro de brácteas libres sobre un pedúnculo de ca. de 6 mm de largo, pubescente, sosteniendo 1–2(–3) flores (Fig. 2). Perianto infundibuliforme, magenta,

Fig. 1. Imagen tipo de *Cuscatlania vulcanicola* Standl. Depositada en el US National Herbarium en 1922.

Fig. 2. *Cuscatlania vulcanicola* Standl. Plantas y flores como ocurren en el campo en la localidad del Lago de Coatepeque (Cantón Las Lajas, Sonsonate) Foto: Frank Sullyvan Cardoza.

puberuleto, con rafidios en la superficie, 2.9–3.3 cm de largo, limbo de 12–13 mm de ancho, tubo ensanchándose gradualmente hacia la base de 1 hasta 3 mm de ancho, estambres (3)5–6, exertos, filamentos desiguales, insertos en la pared del tubo del perianto; estigma capitado, estilo filiforme, ovario oblongo, ca. 1 mm de largo. Fruto un antocarpo, verde claro a pardo claro, oblongo-elipsoide, ligeramente constreñido en el ápice y base, 6.4–7.8 mm de largo, 2.2–3.7 mm de ancho, puberulento, tricomas blanquecinos septados, rafidios en la superficie, 10-costillado, costillas y espacios intercostales ± del mismo ancho, no mucilaginoso cuando húmedo (Fig. 3).

Hábitat.—Selva alta perennifolia y selva mediana subperennifolia. Los dos nuevos registros (localidades) para El Salvador se encuentran en el Departamento de Sonsonate. Una localidad es el Municipio de Caluco, en el Área Natural Protegida Plan de Amayo y la otra localidad está en Cantón Las Lajas, en las cercanías al Lago Coatepeque dentro del Área Natural Protegida San Marcelino (Fig. 4).

Fenología.—Floración de diciembre–marzo y fructificación de enero–abril.

Material examinado.—**EL SALVADOR. Sonsonate. Municipio de Izalco:** A la mitad del camino entre el cementerio El Pacún y Lajamaya, 13°49'52.10"N, 89°34'00.37"W, 950 msnm, 15 dic 2007, *Linares 12938* (MEXU). **Municipio Caluco:** Área Natural Protegida Plan de Mayo, en el sector conocido como El Sunzalito ± a 100 m al N del centro de Operaciones, 13°41'128"N, 89°38'38"W, 325 msnm, 24 ene 2008, *Linares 13440* (MEXU).

Etimología.—El género *Cuscatlania* fue dedicado por el prolífico botánico estadounidense Paul C. Standley (1884–1963), maestro e investigador, quién visitó y recorrió gran parte del país por un período de 6 meses (diciembre de 1921 y mayo de 1922). Antes de la llegada de los españoles en 1524, el pueblo de *Cuscatlán*, era la

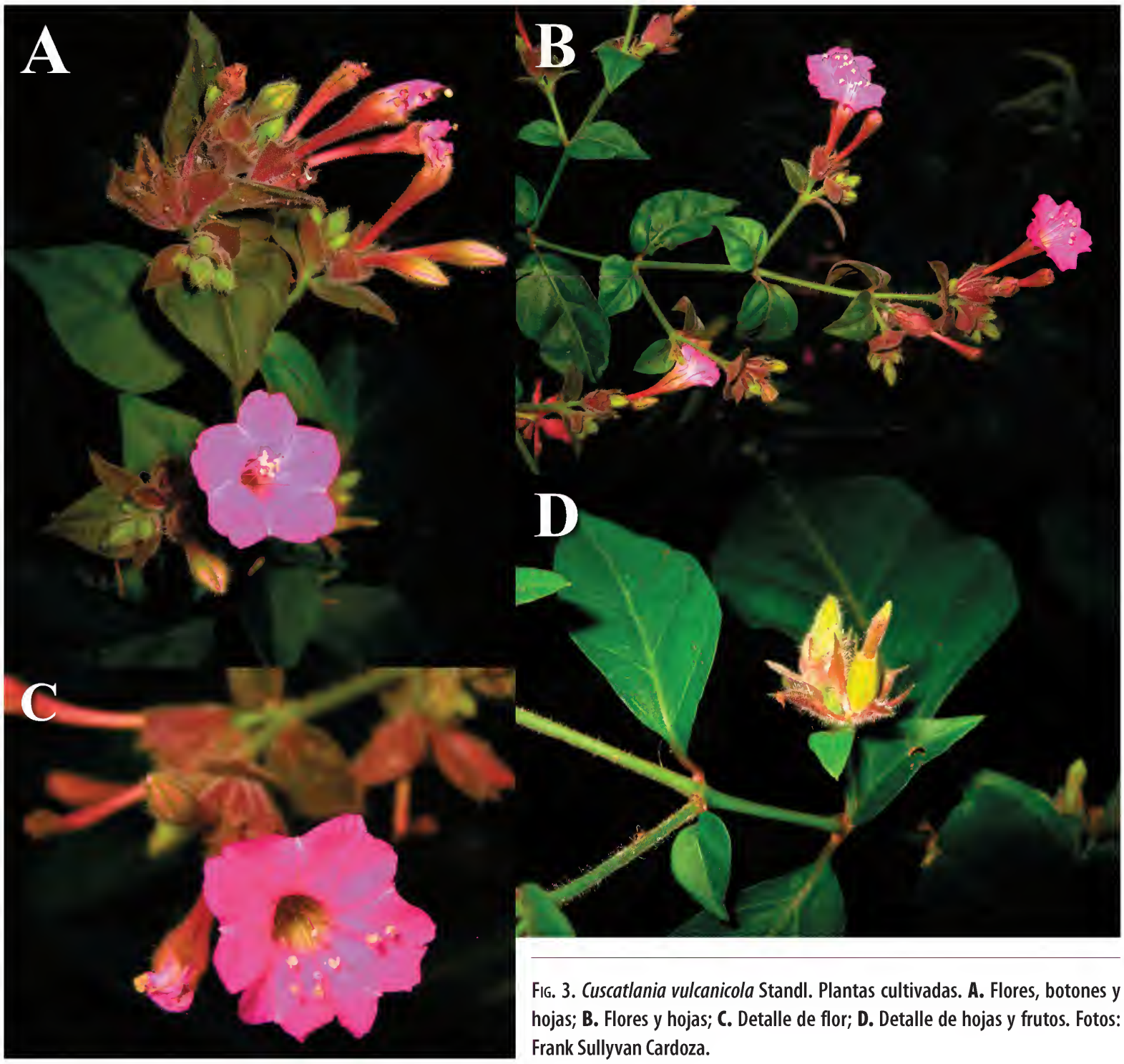


Fig. 3. *Cuscatlania vulcanicola* Standl. Plantas cultivadas. **A.** Flores, botones y hojas; **B.** Flores y hojas; **C.** Detalle de flor; **D.** Detalle de hojas y frutos. Fotos: Frank Sullyvan Cardoza.

provincia nativa más importante de la actual República de El Salvador (Amaroli 1986). El epíteto *vulcanicola*, hace referencia al hábitat donde crece la especie y específicamente al lugar donde se encontró y describió que fue el Volcán de San Vicente, uno de los más importantes del país.

Comentarios.—Esta especie se distingue entre toda la familia, como lo menciona Standley (1923) y Calderón y Standley (1925), por la inserción de los estambres en la pared del tubo del perianto y no por debajo del ovario formando una estructura a manera de copa, como se presenta en los demás representantes de la familia.

Clasificación y afinidades filogenéticas.—Tradicionalmente la clasificación de Nyctaginaceae que prevaleció por más de 15 años fue la de Bittrich y Kühn (1993); en este sistema *Cuscatlania* fue clasificada junto con *Mirabilis*, *Nyctaginia* y *Allionia* (Tabla 1) dentro de la tribu Nyctagineae subtribu Nyctagininnae; dicha subtribu fue caracterizada por incluir hierbas anuales o perennes, con inflorescencias parciales o flores solitarias involucradas. Involucro con brácteas connatas o libres, el estigma papiloso o fimbriado, el polen pantoporado de 100–200 µm de diámetro, con numerosos poros. Recientemente, Douglas y Spellenberg (2010), basados en la hipótesis filogenética de Douglas y Manos (2007) realizaron algunas modificaciones a la clasificación tribal de Nyctaginaceae y aunque en la hipótesis filogenética no se incluyó a *Cuscatlania*, los autores consideran que por similitud morfológica es probable que el género se incluya en la tribu en la que tradicionalmente fue clasificado; sin embargo en este nuevo sistema de clasificación, los autores no reconocieron grupos a nivel de

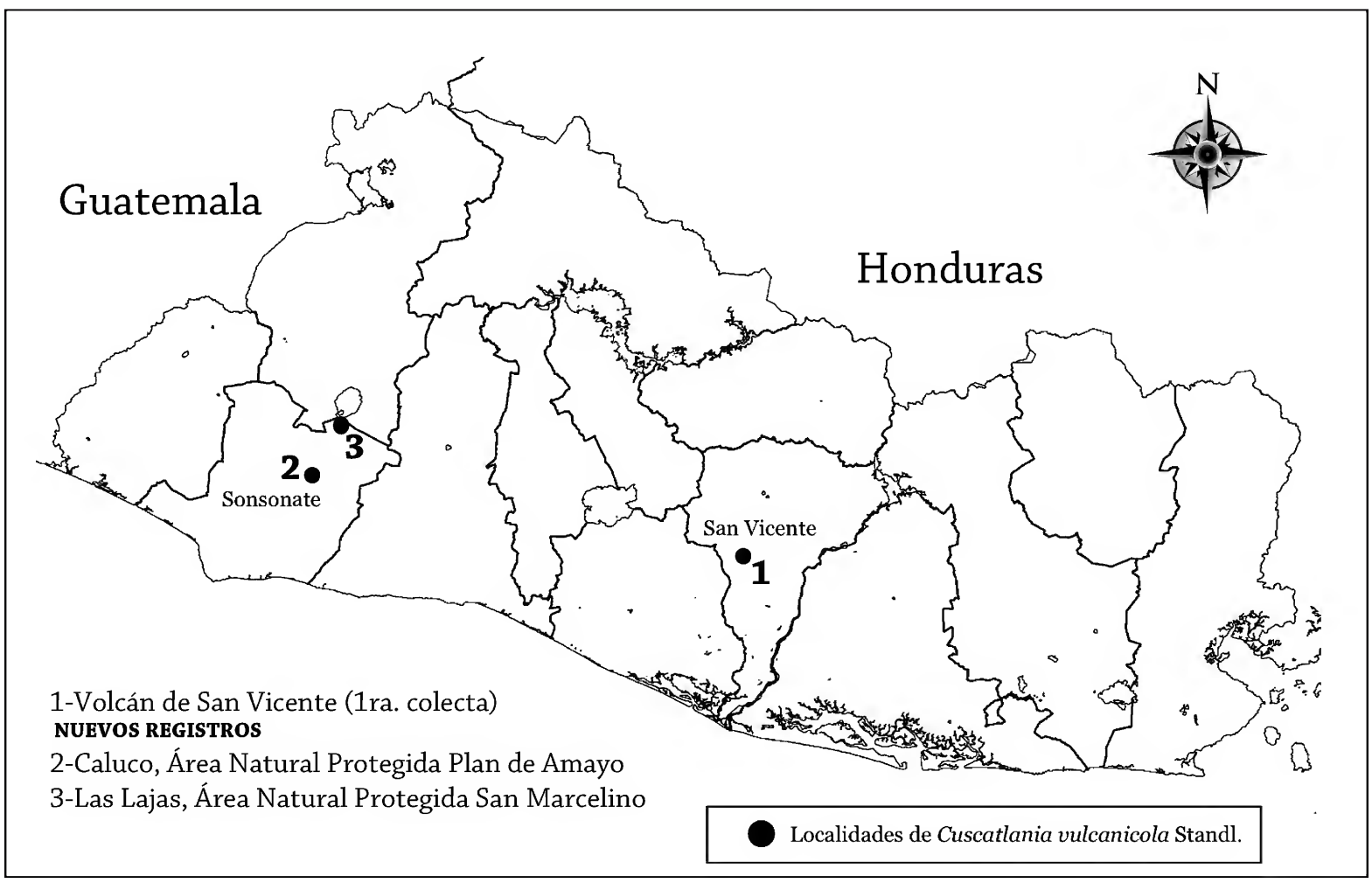


Fig. 4. Distribución geográfica y localidades (nuevos registros) de *Cuscatlania vulcanicola* Standl.

Tabla 1. Afinidades morfológicas de los géneros de la subtribu Nyctagininnae (Bittrich & Kühn 1993).

Morfologia	Allionia	Cuscatlania	Mirabilis	Nyctaginia
Presentación de las brácteas involucrales	Libres	Libres	Principalmente connatas	Libres
Duración de las brácteas involucrales	Persistentes	Persistentes	Persistentes	Persistentes
Desarrollo de las brácteas involucrales	No acrescentes	No acrescentes	Acrescentes	No acrescentes
Inflorescencias	Glomérulo	Cimosas	Cimosas	Capitadas
Número de brácteas por involucro	3	4–8	5	6–20
Número de flores por involucro	3	2–3	1–16	Más de 3
Simetría de las flores	Zigomorfa	Actinomorfa	Actinomorfa	Actinomorfa
Número de estambres	4–7	3–5	3–6	5–8

sutribus. A simple vista, en su aspecto general, el tipo de inflorescencia, número de flores por involucro y color de las flores, *Cuscatlania* recuerda a diversas especies de *Mirabilis* (p. ej., *M. jalapa, M. gracilis, M. sanguinea*). Sin embargo, tomando en cuenta el involucro de brácteas libres no acrescentes, *Cuscatlania* recuerda al género m. onotípico *Nyctaginia*.

CONCLUSIONES

En referencia al Estado de Conservación de esta especie, alto grado de deterioro y fragmentación de su hábitat; la hacen poco frecuentes, considerándose extintas en otras zonas del país. De acuerdo con los criterios de la Lista Roja de Especies Amenazadas (UICN 2012) y según las observaciones de los autores, estas plantas son raras y poco comunes, siendo la categoría para esta especie Vulnerable, VU A1 (d).

AGRADECIMIENTOS

Nuestra gratitud a George Pilz y un revisor anónimo por sus valiosos comentarios y observaciones al manu-

scrito y a Barney Lipscomb por su valiosa revisón y apoyo en todo el proceso de edición de esta publicación que contribuye al conocimiento de la flora salvadoreña.

REFERENCIAS

Amaroli, P. 1986. En la Búsqueda de Cuscatlán: Un proyecto etnohistórico y arqueológico. Manuscrito inédito, Dirección del Patrimonio Cultural, San Salvador.

Bittrich, V. & U. Kühn. 1993. Nyctaginaceae. In: K. Kubitzki, J.G. Rohwer, & V. Bittrich, eds. The families and genera of vascular plants - Dicotyledons 2. Springer-Verlag, Berlin, Germany.

Douglas, N.A. & P.S. Manos. 2007. Molecular phylogeny of Nyctaginaceae: Taxonomy, biogeography and characters associated with a radiation of xerophytic genera in North America. Amer. J. Bot. 94(5):856–872.

Douglas, N. & R. Spellenberg. 2010. A new tribal classification of Nyctaginaceae. Taxon 59(3):905–910.

Linares, J.L. 2009. Flora inventory in southwestern El Salvador. In: O. Komar, ed. Comprehensive inventories of selected biological resources within targeted watersheds and ecological corridors of southwestern El Salvador. Improved Management and Conservation of Critical Watersheds Project, USAID, SalvaNatura, and Gobierno de El Salvador.

Standley, P.C. 1923. New species of plants from El Salvador. J. Washington Acad. Sci. 13(20):437.

Standley, P.C. & S. Calderon. 1925. Lista preliminar de las plantas de El Salvador. Tipografía La Unión, Dutriz Hermanos, San Salvador, El Salvador.

Standley, P.C. & S. Calderon. 1941. Flora Salvadoreña. 2da. Edición. Imprenta Nacional, San Salvador, El Salvador.

JOURNAL NOTICE

Sabeeha S. Merchant, Winslow R. Briggs, and Donald Ort, eds. 2014 (Apr). **Annual Review of Plant Biology, Volume 65.** (ISSN: 1543-5008; ISBN: 978-0-8243-0665-6, hbk). Annual Reviews, Inc., 4139 El Camino Way, P.O. Box 10139, Palo Alto, California 94303, U.S.A. (**Orders:** www.AnnualReviews.org, science@annualreviews.org, 1-800-523-8635, 1-650-493-4400). $101.00, 790 pp., 7.5" × 9.25".

ABOUT THIS JOURNAL— The *Annual Review of Plant Biology*, in publication since 1950, covers the significant developments in the field of Plant Biology, including Biochemistry and Biosynthesis, Genetics, Genomics and Molecular Biology, Cell Differentiation, Tissue, Organ and Whole Plant Events, Acclimation and Adaptation, and Methods and Model Organisms.

Contents of Volume 65:

Introduction—Sabeeha S. Merchant

1. Our Eclectic Adventures in the Slower Eras of Photosynthesis: From New England Down Under to Biosphere 2 and Beyond—*Barry Osmond*
2. Sucrose Metabolism: Gateway to Diverse Carbon Use and Sugar Signaling—*Yong-Ling Ruan*
3. The Cell Biology of Cellulose Synthesis—*Heather E. McFarlane, Anett Döring, and Staffan Persson*
4. Phosphate Nutrition: Improving Low-Phosphate Tolerance in Crops—*Damar Lizbeth López-Arredondo, Marco Antonio Leyva-González, Sandra Isabel González-Morales, José López-Bucio, and Luis Herrera-Estrella*
5. Iron Cofactor Assembly in Plants—*Janneke Balk and Theresia A. Schaedler*
6. Cyanogenic Glycosides: Synthesis, Physiology, and Phenotypic Plasticity—*Roslyn M. Gleadow and Birger Lindberg Møller*
7. Engineering Complex Metabolic Pathways in Plants—*Gemma Farré, Dieter Blancquaert, Teresa Capell, Dominique Van Der Straeten, Paul Christou, and Changfu Zhu*
8. Triterpene Biosynthesis in Plants—*Ramesha Thimmappa, Katrin Geisler, Thomas Louveau, Paul O'Maille, and Anne Osbourn*
9. To Gibberellins and Beyond! Surveying the Evolution of (Di)Terpenoid Metabolism—*Jiachen Zi, Sibongile Mafu, and Reuben J. Peters*
10. Regulation and Dynamics of the Light-Harvesting System—*Jean-David Rochaix*
11. Gene Expression Regulation in Photomorphogenesis from the Perspective of the Central Dogma—*Shu-Hsing Wu*
12. Light Regulation of Plant Defense—*Carlos L. Ballaré*
13. Heterotrimeric G Protein–Coupled Signaling in Plants—*Daisuke Urano and Alan M. Jones*
14. Posttranslationally Modified Small-Peptide Signals in Plants—*Yoshikatsu Matsubayashi*
15. Pentatricopeptide Repeat Proteins in Plants—*Alice Barkan and Ian Small*
16. Division and Dynamic Morphology of Plastids—*Katherine W. Osteryoung and Kevin A. Pyke*
17. The Diversity, Biogenesis, and Activities of Endogenous Silencing Small RNAs in *Arabidopsis*—*Nicolas G. Bologna and Olivier Voinnet*
18. The Contributions of Transposable Elements to the Structure, Function, and Evolution of Plant Genomes—*Jeffrey L. Bennetzen and Hao Wang*
19. Natural Variations and Genome-Wide Association Studies in Crop Plants—*Xuehui Huang and Bin Han*
20. Molecular Control of Grass Inflorescence Development—*Dabing Zhang and Zheng Yuan*
21. Male Sterility and Fertility Restoration in Crops—*Letian Chen and Yao-Guang Liu*
22. Molecular Control of Cell Specification and Cell Differentiation During Procambial Development—*Kaori Miyashima Furuta, Eva Hellmann, and Ykä Helariutta*
23. Adventitious Roots and Lateral Roots: Similarities and Differences—*Catherine Bellini, Daniel I. Pacurar, and Irene Perrone*
24. Nonstructural Carbon in Woody Plants—*Michael C. Dietze, Anna Sala, Mariah S. Carbone, Claudia I. Czimczik, Joshua A. Mantooth, Andrew D. Richardson, and Rodrigo Vargas*
25. Plant Interactions with Multiple Insect Herbivores: From Community to Genes—*Jeltje M. Stam, Anneke Kroes, Yehua Li, Rieta Gols, Joop J.A. van Loon, Erik H. Poelman, and Marcel Dicke*
26. Genetic Engineering and Breeding of Drought-Resistant Crops—*Honghong Hu and Lizhong Xiong*
27. Plant Molecular Pharming for the Treatment of Chronic and Infectious Diseases—*Eva Stoger, Rainer Fischer, Maurice Moloney, and Julian K.-C. Ma*
28. Genetically Engineered Crops: From Idea to Product—*Jose Rafael Prado, Gerrit Segers, Toni Voelker, Dave Carson, Raymond Dobert, Jonathan Phillips, Kevin Cook, Camilo Cornejo, Josh Monken, Laura Grapes, Tracey Reynolds, and Susan Martino-Catt*

VASCULAR PLANT FLORA OF THE ALPINE ZONE IN THE SOUTHERN ROCKY MOUNTAINS, U.S.A.

James F. Fowler

U.S. Forest Service
Rocky Mountain Research Station
2500 S. Pine Knoll Drive
Flagstaff, Arizona 86001, U.S.A.
jffowler@fs.fed.us

B.E. Nelson and Ronald L. Hartman

Rocky Mountain Herbarium
Department of Botany, 3165
1000 E. University Ave.
Laramie, Wyoming 82071, U.S.A.
bnelsonn@uwyo.edu; rhartman@uwyo.edu

ABSTRACT

Field detection of changes in occurrence, distribution, or abundance of alpine plant species is predicated on knowledge of which species are in specific locations. The alpine zone of the Southern Rocky Mountain Region has been systematically inventoried by the staff and floristics graduate students from the Rocky Mountain Herbarium over the last 27 years. It is centered on the mountain ranges of Colorado and extends north to the Medicine Bow Mountains in southeast Wyoming and south into the Sangre de Cristo Range in north central New Mexico. It also includes the La Sal Mountains of Utah and the San Francisco Peaks in northern Arizona. The alpine meadow and treeline ecotone flora of the Southern Rocky Mountains includes 609 unique taxa of vascular plants comprising 581 species. The richest families are Asteraceae (104 species), Poaceae (58 species), Cyperaceae (57 species), and Brassicaceae (42 species). The central Colorado subregion is the most taxon rich (499) with richness tapering off to the north, southeast, and southwest. Non-endemic alpine zone taxa occur more frequently elsewhere in the Rocky Mountain Cordillera Floristic Region (515) than in the Madrean (373), Circumboreal (226), or North American Atlantic Floristic Regions (120). Levels of endemism within the flora of the alpine zone in the Southern Rocky Mountains range from single mountains (7) to the flora as a whole (59) including 25 taxa endemic to both the Southern Rockies and to its alpine zone. This checklist is based on vouchered specimens and should be most useful to botanists and land managers determining what taxa are likely to occur within their area of interest.

RESUMEN

La detección de cambios en ocurrencia, distribución, o abundancia de especies de plantas alpinas se predica como conocimiento de que especies están en lugares específicos. La zona alpina del sur de la Región de las Montañas Rocosas ha sido inventariada sistemáticamente por el personal y estudiantes de florística del Rocky Mountain Herbarium en los últimos 27 años. Está centrado en las cordilleras de Colorado y se extiende hacia el norte hasta las montañas Medicine Bow en el sureste de Wyoming y hacia el sur hasta la cadena Sangre de Cristo en el norte centro de Nuevo México. También incluye las montañas La Sal de Utah y los picos San Francisco en el norte de Arizona. La pradera alpina y la flora del ecotono de la línea arbolada del sur de las Rocky Mountains incluye 609 taxa únicos de plantas vasculares que comprenden 581 especies. Las familias más ricas son Asteraceae (104 especies), Poaceae (58 especies), Cyperaceae (57 especies), y Brassicaceae (42 especies). La subregión de Colorado central es la más rica en taxa (499) cuya riqueza disminuye hacia el norte, sureste, y suroeste. Los taxa no endémicos de la zona alpina ocurren más frecuentemente en cualquier lugar de la Región Florística de la Cordillera Rocky Mountain (515) que en la Madreana (373), Circumboreal (226), o las Regiones Florísticas Atlánticas Norte Americanas (120). Los niveles de endemismo en la flora de la zona alpina de las Southern Rocky Mountains varía de montañas simples (7) a la flora como conjunto (59) que incluye 25 taxa endémicos de las Southern Rockies y su zona alpina. El catálogo está basado en especímenes testigo y puede que sea útil a los botánicos y gestores del territorio para determinar que taxa puede que existan en su área de interés.

INTRODUCTION

Field detection of changes in occurrence, distribution, or abundance of alpine plant species is predicated on knowledge of which species are in specific locations. Baseline surveys for this purpose are anchored in the elucidation of regional species pools; therefore, what species could occur at the chosen baseline survey sites. High quality baseline study design to detect change at local and regional scales also hinges on the synergistic ability of plant systematists, ecologists, and land managers to identify and track individual species as systematic, ecological, and evolutionary entities. Alpine species in their mountaintop habitats have limited opportunity to migrate upslope or northward and may be more vulnerable to local extinction (Chapin & Körner 1994; Grabherr et al. 1994; Theurillat & Guisan 2001). Concerns of biodiversity managers regarding the potential loss of alpine vascular plant species due to global warming often center on possible inadequate rates of species migra-

tion or microevolutionary adaptation. Recent studies have shown or predicted a variety of species responses to increased temperatures and changes in precipitation patterns in montane and alpine zones (e.g., Crimmins et al. 2011; Pauli et al. 2012). In the Southern Rocky Mountains, determination of the regional alpine plant species pool should allow baseline studies to be more effective at detecting real change.

Completion of 4,000–13,000 km^2 scale floristic inventories containing alpine areas by the staff and floristic graduate students from the Rocky Mountain Herbarium (RM) over the past 27 years (Kastning 1990; Vanderhorst 1993; Lyon 1996; Chumley 1998; Moore 1998; Elliott 2000; Taylor 2000; Nunn 2003; Arnett 2002; Holt 2002; Foley 2006; Reif 2006; Flaig 2007; Larson 2008; Legler 2010; Lukas et al. 2012; Brummer 2014; and Kirkpatrick 2014; also Nelson 1974, 1984) presents an opportunity to synthesize species occurrence and distribution information for the entire Southern Rocky Mountain Region. The ongoing efforts of the Flora of North America (FNA 1993+) project to standardize species circumscriptions and nomenclature transcends the more fragmented data contained in state floras such as Weber and Wittmann (2012), Dorn (2001), and Allred and Ivey (2012). The recently completed Intermountain Flora (Cronquist et al. 1972; Cronquist et al. 1977, 1989, 1997, 1994; Cronquist et al. 1984; Holmgren et al. 2005; Holmgren et al. 2012) illustrates what can be achieved on a physiographic scale. There are a few alpine specific checklists for small areas within the Rocky Mountain Cordillera (Little 1941; Johnson & Billings 1962; Spence & Shaw 1981; Rundel et al. 2008) but not for the entire Southern Rocky Mountain Region. The purpose of this study is to document the occurrence of vascular plant species in the alpine zone of the Southern Rockies using voucher specimen information from the two largest regional herbaria: Rocky Mountain Herbarium and University of Colorado Herbarium (COLO). Species distribution within the Southern Rocky Mountain region and by habitat within the alpine zone is a secondary goal. The resulting checklist will serve as a reference for both land managers and researchers when establishing site specific baseline studies to detect changes in plant distribution and occurrence.

Study Area

The Southern Rocky Mountain Region (Arno & Hammerly 1984, Fig. 1) is the southern portion of the proposed boundaries for the Flora of the Rocky Mountains Project (Hartman 1992). It is centered on the mountain ranges of Colorado and extends north to the Medicine Bow Mountains in southeast Wyoming and south into the Sangre de Cristo Range of north central New Mexico. It also includes the La Sal Mountains of Utah (Hartman 1992) and adds the San Francisco Peaks in northern Arizona due to floristic similarities (Little 1941; Schaak 1983). Colorado was divided into four contiguous subregions (Fig. 1) based on state lines (Wyoming and New Mexico) and by major highway corridors (I-25, I-70, US Hwy. 50, and by US Hwy. 285 south of US Hwy. 50). Thus Colorado is separated into north, central, southeast, and southwest geographic components.

Our area of interest is the alpine zone comprised of meadow and treeline ecotone areas of the Southern Rockies as defined by Körner (1998, 2003). Timberline is the local upper elevational limit of closed canopy forest; treeline is the general upper limit of scattered clumps of upright trees greater than three meters in height; treeline ecotone is the transition region between timberline and treeline with a mix of upright trees and herbaceous vegetation; and alpine meadow is the herbaceous plant dominated region above treeline, but often includes dwarf shrubs, scattered single trees, krummholz, and patchily vegetated talus, rock outcrops, and peaks. In the Southern Rockies, the alpine zone starts at 3350 m in southeast Wyoming and gradually rises to begin at 3540 m in northern New Mexico.

Most of the study area is within the Southern Rocky Mountain Province of the Rocky Mountains Physiographic System (Hunt 1974; Brouillet & Whetstone 1993). The predominantly north-south oriented mountain ranges from the southeast Wyoming subregion through the north, central, and southeast Colorado subregions to the northern New Mexico subregion are underlain by weathered granitic formations while the San Juan Mountains in the southwest Colorado subregion are of volcanic origin. Both the Utah and Arizona subregions are within the Colorado Plateau Physiographic Province. The La Sal Mountains are the result of laccolithic intrusions and have exposed igneous rocks above timberline (Baars 1983; Blakey & Ranney 2008). The San Francisco Peaks are the collapsed caldera edge of a stratovolcano (Nations & Stump 1981). Surface topography within the study area is quite variable and rugged due to uplift, erosion, and glaciation, but it also includes

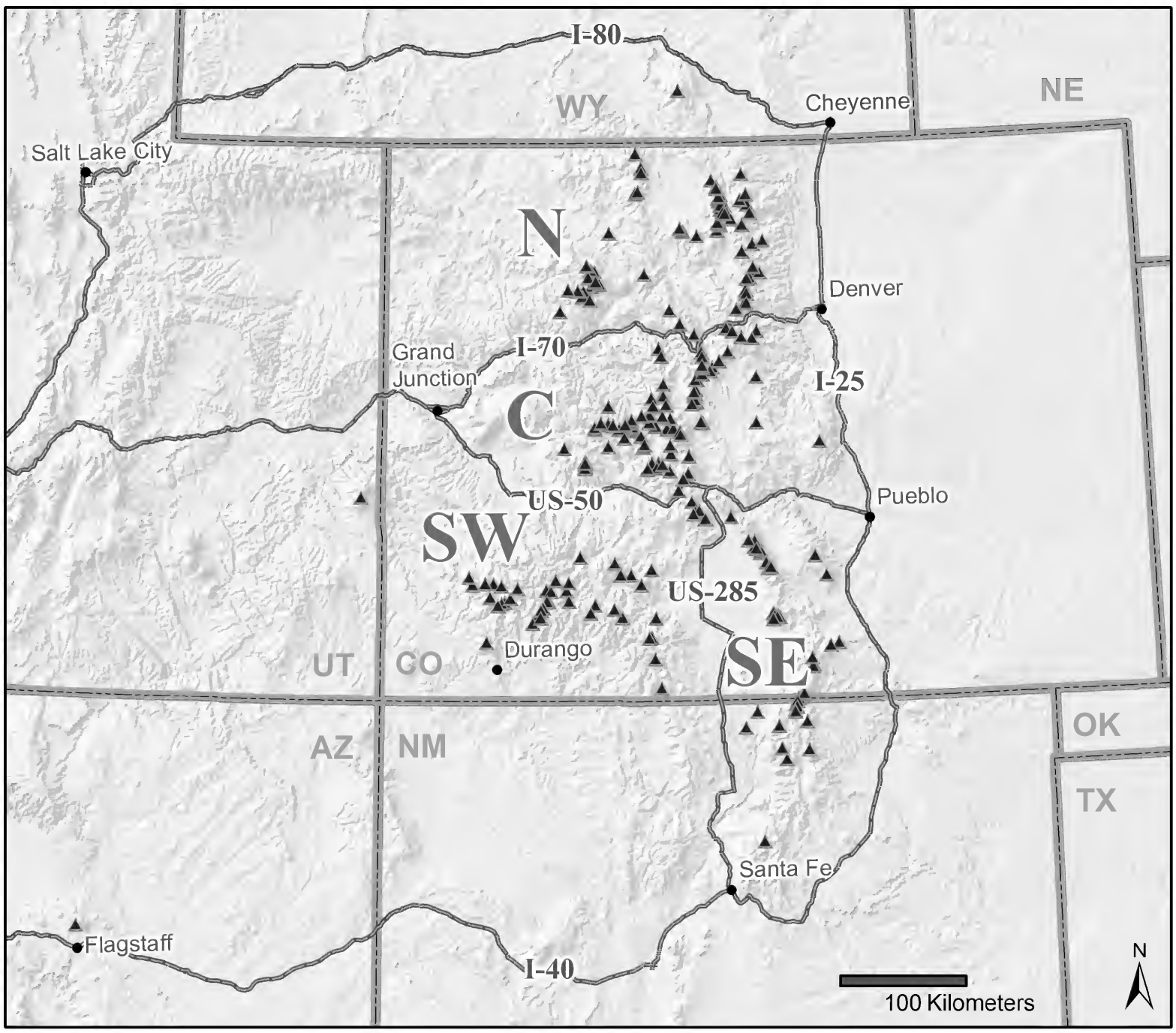


Fig. 1. Study area map for the alpine zone vascular plant flora of the Southern Rocky Mountains. Triangles indicate the 245 collections sites each of which may represent several individual collections at the RM and COLO. The eight sub-regions within the Southern Rockies are by state (AZ, NM, UT, WY) and within Colorado by four sub-regions using highways that follow major physiographic separations. N = northern Colorado mountain ranges, C = central Colorado mountain ranges, SW = San Juan Mountains, SE = southeastern Colorado mountain ranges.

extensive alpine meadows on round topped ridges that have escaped glaciation since before the Wisconsin epoch (Marr 1967).

The climate of the Southern Rockies has two primary periods of precipitation, summer and winter (Arno & Hammerly 1984). Most summer precipitation originates from southern air masses while winter snows enter from the North Pacific (Arno & Hammerly 1984). At Niwot Ridge (3740 m elevation) in northern Colorado, July mean temperature is 8°C (Billings 2000) and summers are cool with frequent thunderstorms, sometimes with hail and sleet, with a short growing season of 45 days (Marr 1967). Winters are long, cold, and windy with frequent blizzards and a minimum temperature of about -28°C at Niwot Ridge (Marr 1967); January mean temperature is -14°C (Billings 2000). Mean annual temperature at Niwot Ridge is -3.8°C; mean annual precipitation ranges from 66-86 cm; and mean annual windspeed is 25 km/hr (Marr 1967).

METHODS

The alpine areas have been systematically inventoried by the staff and floristics graduate students from the RM. This study is largely a synthesis of RM collections verified by Hartman or Nelson over the past few de-

cades, as well as those housed at the University of Colorado (COLO). The area covered is southeast Wyoming, Colorado, north central New Mexico, the La Sal Mountains in southeast Utah, and the San Francisco Peaks in northern Arizona. From the two databases, we chose 245 collection sites. In searching the databases, the term "alpine" was first sought followed by elevation adjusted by latitude. Sites chosen from the RM database were known and collected by at least one of the authors and associated graduate students. From the COLO database, sites were sorted by county and if site elevation was above the known alpine zone and had more than 20 collections, specimen labels were searched for "alpine" and if present, included on the initial species list. This list was extensively vetted for specimens that appeared to be out of geographic or elevational range. Taxonomic and geographic data were pulled from the RM and COLO plant specimen databases. Habitat data was not always available from the specimen record, in which case, habitat assignment was based on the authors' knowledge of the site and the collector. Lists of species from each location were recorded in an expanded spreadsheet.

Systematics and nomenclature follow the published volumes of *Flora of North America* (FNA 1993+) with minor exceptions and follow current taxonomic usage at the RM for families not yet revised by FNA. Exceptions to FNA include recognition of Dorn's treatment for *Salix* (Dorn 2010), *Packera öodes* (Rydb.) W.A. Weber as a segregate of *Packera streptanthifolia*, *Trisetum montanum* Vasey as a segregate of *Trisetum spicatum,* and *Abies arizonica* Merriam as a segregate of *Abies bifolia*. Floristic region classification is based on Thorne's (1993) phytogeography treatment for FNA. Levels of endemism were determined by the authors based on distribution maps published in FNA, from RM and USDA Plants online databases, and from geographic distributions published in the Intermountain Flora (Cronquist et al. 1972; Cronquist et al. 1977, 1989, 1997, 1994; Cronquist et al. 1997; Holmgren et al. 2005; Holmgren et al. 2012) and state floras. The RM database was thoroughly searched (beyond our sites) for putative Southern Rockies and alpine endemics to verify our designations. Disjunct populations of taxa are separated by at least one state or province. Our use of the term "alpine endemic" indicates vascular plant taxa that are distributionally restricted to the alpine zone of the Rocky Mountain Cordillera, unlike Körner (2003) who includes these taxa along with taxa that are distributionally centered in the alpine zone as "alpine taxa." Threatened, Endangered, and Sensitive (TES) species designation were taken from each state's natural heritage/rare plants database.

RESULTS

The alpine meadow, talus, and treeline ecotone flora of the Southern Rocky Mountains includes 609 unique taxa (species, varieties, and subspecies) of vascular plants comprising 581 species (Table 1). The richest families are Asteraceae (104 species), Poaceae (58 species), Cyperaceae (57 species), and Brassicaceae (42 species) (Table 2). The most speciose genera are *Carex* (Cyperaceae, 51 species), *Draba* (Brassicaceae, 23 species), *Erigeron* (Asteraceae, 18 species), and *Poa* (Poaceae, 16 species).

Within the eight subregions of this flora, distribution and frequency of occurrence varies by taxon. Occurrences in Table 2 show subregional distribution and give some indication of relative abundance within each taxon. Between taxa frequency-of-occurrence comparisons may not be valid due to collection biases. Examples range from the widespread and common *Geum rossii* to the infrequent single mountain endemic, *Senecio fremontii* var. *inexpectatus*.

The central Colorado subregion is the most taxon rich at 499. Richness tapers off to the north, southeast, and southwest, dropping to 127 and 211 at the north and south ends of the contiguous Southern Rockies in Wyoming and New Mexico, respectively. The east-west trending Hoosier Ridge in central Colorado, which has been repeatedly surveyed, has 180 taxa alone. The more insular La Sal Mountains of Utah are similar to the north (Wyoming) end with 130 taxa, and the yet more distant San Francisco Peaks of Arizona have only 58 vascular plant taxa in our data set.

Species occurrences between alpine meadow/treeline ecotone areas are also variable. Some species such as *Minuartia obtusiloba, Carex elynoides,* and *Hymenoxys grandiflora* occur mostly in alpine meadows whereas many species occur throughout both areas; for example, *Micranthes rhomboidea* (Table 2). Trees define the treeline ecotone area, but very few herbaceous species occur only there and those few are probable outliers

TABLE 1. Summary of search results for Southern Rocky Mountain vascular plants in alpine and treeline ecotone habitats. The survey includes collections from 245 sites in the USFS, RM, and COLO herbaria databases. Disjunct populations are separated from larger populations by at least one state or province. Threatened, Endangered, and Sensitive (TES) species are officially listed under the Endangered Species Act or by US National Forest Regions.

List by Taxonomic Category		List by special category	
Families	50	Endemic to Southern Rocky Mountains	59
Genera	213	Endemic to Alpine/treeline ecotone habitats	37
Species	581	Endemic to a single mountain range	7
Infraspecies	28	Disjunct population(s)	24
Unique taxa	609	TES species	20
		Exotic to Southern Rocky Mountains	11

from lower elevation habitats. Even the conifers *Abies bifolia* and *Picea engelmannii* occur as single trees above the upper treeline ecotone boundary within alpine meadow, although their main abundance is within the closed forest below timberline. Occurrences shown in Table 2 indicate relative habitat preference within the alpine zone of each subregion.

The non-endemic Southern Rocky Mountain alpine zone taxa occur more frequently elsewhere in the Rocky Mountain Cordillera Floristic Region (515) than in the Madrean (373), Circumboreal (226), or North American Atlantic Floristic Regions (120). Most (21 of 24) of the disjunct taxa in this flora are shared with the Circumboreal Floristic Region and northern part of the Rocky Mountain Cordillera Floristic Region. For example, the Colorado and Utah (Uintah Mountains) populations of *Armeria maritima* ssp. *sibirica* are separated by over 1500 kilometers from its main distribution in the circumboreal and arctic regions.

The levels of endemism within the flora of the alpine zone in the Southern Rocky Mountains (Table 1) range from a single peak or mountain range (7 taxa) to the flora as a whole (59 taxa). Notably 25 taxa are endemic to both the Southern Rockies and to its alpine zone. The alpine zone endemics represent 13 families and 24 genera with *Poa* and *Draba* each having four alpine endemic taxa. Alpine zone endemics also include two Endangered Species Act (ESA) Threatened species: *Packera franciscana* from the San Francisco Peaks of northern Arizona and *Eutrema penlandii* from the Mosquito Range of central Colorado. The latter species is listed as *Eutrema edwardsii* in Table 2 since *E. penlandii* was recently synonymized prior to publication of the Flora of North America. However, the disjunct Colorado population of *E. edwardsii* (from northern British Columbia) is still officially listed as Threatened *E. penlandii* pending further review and analysis. The remaining 18 Sensitive species (Table 1) are listed by individual National Forest Regional Offices (Table 2).

DISCUSSION

This study was intended to provide a species checklist for the entire Southern Rocky Mountain alpine zone along with some indication of subregional distribution. We chose a more conservative approach to species occurrence that leans toward errors of omission rather than errors of commission that might result from misidentified specimens in a database only approach. Finer scale distribution by major mountain range within subregions awaits further biogeographical study.

Scott (1995) indicated 609 alpine plant species for the Middle Rockies, however, Hadley (1987) counted 619 alpine species for the Middle and Southern Rocky Mountain regions combined. Our checklist shows 581 alpine zone species from the Southern Rockies (Table 1). These counts are comparable to Körner's (2003) estimate of 600 alpine species for larger mountain systems based on a known alpine species richness for the entire Swiss Alps of approximately 650 and data showing a 150-550 alpine plant species richness range for many smaller Swiss alpine floras (10-100 km^2). Species richness data from smaller North American alpine floras are also within Körner's observed range: Ruby Range of Colorado (220 species, Hartman & Rottman 1987), Teton Range of Wyoming (260 species, Spence & Shaw 1981), Beartooth Plateau of Montana (210 species, Johnson & Billings 1962), and White Mountains of California (163 species, Rundel et al. 2008). The larger scale estimates from the Rocky Mountains also support Körner's conjecture that smaller mountain range components

Table 2. Alpine/treeline vascular plant species list for the Southern Rocky Mountains: southeast Wyoming, Colorado, northern New Mexico, La Sal Mountains of Utah, and San Francisco Peaks of Arizona. Number of occurrences within our data from 245 sites are shown by subregion and habitat. Colorado subregions are Northern (n), Central (c), Southwestern (sw), and Southeastern (se), with number of sites examined in parentheses. A = alpine meadow, talus, and turf above treeline (defined as general line at upper edge of clusters of upright trees > 3 m, excluding more isolated single trees), T = treeline ecotone, region below treeline and above timberline (defined as upper edge of relatively closed canopy forest). Taxa from COLO are indicated with C and not assigned to T or A microhabitats. North American Floristic Regions include: Rocky Mountain Cordillera (R), Circumboreal (C), Madrean (M), and Atlantic (A) with exotic indicating that the taxon is not native to the Southern Rocky Mountains. Level of endemism is shown for Southern Rocky Mountain endemics (SRxE), alpine habitat endemics (AE), and taxa that are disjunct from the Southern Rocky Mountain populations by at least one state or province. Total of 609 unique taxa.

Subregions Family/Species	WY (n=1)	n CO (n=119)	c CO (n=98)	sw CO (n=40)	se CO (n=33)	UT (n=1)	AZ (n=1)	NM (n=14)	Floristic Region	Endemic
FERNS AND FERN ALLIES										
Aspleniaceae										
Asplenium trichomanes-ramosum L.				1C	1C				RCA	
Dryopteridaceae										
Athyrium alpestre (Hoppe) Clairv. var. americanum Butters			1A 1T 1C						RM	
Cystopteris fragilis (L.) Bernh.	1A 11T	11A 1T 4C	15A 3T 5C	4A 2T 5C	3A 3C	1A	1A	3A	RCMA	
Cystopteris reevesiana Lellinger				1A 1C	4A		1A 1T		RM	
Polystichum lonchitis (L.) Roth		2C	1C						RCA	
Woodsia oregana D.C. Eaton var. cathcartiana (B.L. Rob.) C.V. Morton					4A 1T				RMA	
Equisetaceae										
Equisetum arvense L.		1C		1A					RCMA	
Equisetum laevigatum A. Braun					1A 1T				RMA	
Isoëtaceae										
Isoëtes bolanderi Engelm. var. bolanderi				1C					RM	
Lycopodiaceae										
Huperzia haleakalae (Brack.) Holub		1C	1C						RC	disjunct
Lycopodium annotinum L.		2C	2C						RCMA	
Ophioglossaceae										
Botrychium echo W.H. Wagner			1A 1T	1C					RM	
Botrychium hesperium (Maxon & R.T. Clausen) W.H. Wagner & Lellinger			1A 1T						RM	
Botrychium lanceolatum (S.G. Gmel.) Ångstr. var. lanceolatum		2A		1C				1A	RCM	
Botrychium lunaria (L.) Sw.			1A 1C						RCM	
Botrychium minganense Vict.				1C				2A	RCMA	
Pteridaceae										
Cryptogramma acrostichoides R. Br.	1A	4A 2T 1C	1T 2C	1A 1T 1C	3A			3A	RCMA	
Pellaea breweri D.C. Eaton		1A							RM	
Selaginellaceae										
Selaginella densa Rydb.	1A 11T	7A 1C	12A 1T 6C	4A 2T 2C	4A 1C	1A		8A	RA	
Selaginella weatherbiana R.M. Tryon					2A			1A	R	
GYMNOSPERMS										
Cupressaceae										
Juniperus communis L. var. depressa Pursh	1A	3A 2T 1C	2A 3T 2C	3A 3T 1C	2A	1T	1T	3A 1T	RCMA	

Table 2. (continued)

Subregions Family/Species	WY (n=1)	n CO (n=119)	c CO (n=98)	sw CO (n=40)	se CO (n=33)	UT (n=1)	AZ (n=1)	NM (n=14)	Floristic Region	Endemic
Pinaceae										
Abies arizonica Merriam					1A				RM	
Abies bifolia A. Murray bis	1A	1A 3T 1C	1A 2T 1C		1A	1T			RM	
Picea engelmannii Parry ex Engelm. var. engelmannii	1A	6A 1T 1C	7A 9T 2C	3A 3T	2A	1T	1T	2A	RM	
Picea pungens Engelm.				5A 1T	1A			1A 1T	RM	
Pinus aristata Engelm.			2A 4T 1C	1A	3A		1T	4A 2T	R	SRxE
Pinus contorta Douglas ex Loudon var. latifolia Engelm.			2A 1T	1A					RC	
ANGIOSPERMS										
Adoxaceae										
Adoxa moschatellina L.		1C	2C	1A 6C	3A			1A	RCA	
Sambucus racemosa L. var. microbotrys (Rydb.) Kearney & Peebles			3A 1T 2C	2C	1A	1T			RM	
Amaranthaceae										
Chenopodium atrovirens Rydb.		1C			1A 1C				RM	
Chenopodium capitatum (L.) Ambrosi var. capitatum		1A							RCMA	
Chenopodium pratericola Rydb.					1A				RMA	
Apiaceae										
Angelica grayi (J.M. Coult. & Rose) J.M. Coult. & Rose	1A	7A 1C	22A 5T 12C	13A 3T 4C	10A 1C			4A	R	SRxE
Bupleurum americanum J.M. Coult. & Rose				1C					RC	
Conioselinum scopulorum (A. Gray) J.M. Coult. & Rose			1A	2A					RM	
Cymopterus alpinus A. Gray		10A 1T 3C	23A 1T 12C	1A 1C	7A 3C	1A	1A	1A	RM	
Cymopterus bakeri (J.M. Coult. & Rose) M. E. Jones			1A 3C	10A 3T 5C	22A 3C	1A		8A 2T	R	SRxE-AE
Cymopterus humilis (Raf.) Tidestr. & Kittell[1]			1C						R	SRxE-AE
Cymopterus lemmonii (J.M. Coult. & Rose) Dorn		14A 1T 1C	19A 6T 7C	17A 5T 7C	12A	1A 1T	1A 1T	1A	RM	
Cymopterus longilobus (Rydb.) W.A. Weber					2A	1A		2A 1T	RM	
Ligusticum porteri J.M. Coult. & Rose var. porteri		1T		6A 1T 2C	1A				RM	
Ligusticum tenuifolium S. Watson		1A 2C	3A 2C						R	
Oxypolis fendleri (A. Gray) A. Heller			4A 1T	5A 1T 2C	1T				RM	
Podistera eastwoodiae (J.M. Coult. & Rose) Mathias & Constance		5A 2T 1C	3A 3C	12A 2T 5C	5A	1T		7A 2T	R	SRxE
Asteraceae										
Achillea millefolium L.	1A	14A 2C	30A 6T 6C	6A 1T 4C	5A	1A 1T		7A 3T	RCMA	
Agoseris aurantiaca (Hook.) Greene		7A 1C	8A 1T 2C	6A 4T 1C	8A 1T	1T		4A 1T	RCM	
Agoseris glauca (Pursh) Raf. var. dasycephala (Torr. & A. Gray) Jeps.		8A 3C	15A 3T 4C	3A 1T 3C	2A	1A 1T		1A	RCA	
Agoseris parviflora (Nutt.) D. Dietrich			5A 2T						RM	
Antennaria anaphaloides Rydb.		3A 2C	6A 2T 1C		2A 1C				RM	
Antennaria corymbosa E.E. Nelson		1A	1A 1T	2A 1T					RM	
Antennaria marginata Greene					1A 1T				RM	
Antennaria media Greene	1A	13A 5C	19A 2T 10C	9A 2T 4C	4A 1C			5A 1T	RCM	

Table 2. (continued)

Subregions Family/Species	WY (n=1)	n CO (n=119)	c CO (n=98)	sw CO (n=40)	se CO (n=33)	UT (n=1)	AZ (n=1)	NM (n=14)	Floristic Region	Endemic
Antennaria microphylla Rydb.		1A	3A 1T		3A			2A	RCMA	
Antennaria parvifolia Nutt.				3A	1A			1A	RMA	
Antennaria rosea Greene		3A 2C	17A 5T 4C	7A 3T 1C	7A 2C	1A 1T		6A 1T	RCMA	
Antennaria umbrinella Rydb.		9A 1T	16A 3T 8C	4A 1T 4C	7A 2C	1A 1T		2A 1T	RM	
Arnica angustifolia Vahl ssp. tomentosa (Macoun) G.W. Douglas & G. Ruyle-Douglas			2C						RC	disjunct
Arnica cordifolia Hook.		1A 3C	5A 2T 2C	3A 3T 1C	1A	1T			RCMA	
Arnica gracilis Rydb.		2A							R	
Arnica latifolia Bong.			1C	1A 1C					RC	
Arnica mollis Hook.		8A 1T 2C	9A 3T 7C	5A 1T 3C	1A				RCM	
Arnica parryi A. Gray		2A 1T 1C	7A 4T 1C	1A 1T					RM	
Arnica rydbergii Greene		5A 1T	9A 3T 4C		1A				R	
Artemisia borealis Pall. ssp. borealis		1A 4C	5A 1T 12C	1A 2C	2A 3C				RC	
Artemisia campestris L. ssp. pacifica (Nutt.) H.M. Hall & Clements		1A	6A 1T	9A	8A				RCM	
Artemisia frigida Willd.		1A	2A 1C		1A 1C				RCMA	
Artemisia laciniata Willd. ssp. parryi (A. Gray) W.A. Weber			3A						R	
Artemisia ludoviciana Nutt. var. ludoviciana					7A				RCMA	
Artemisia michauxiana Besser		1T		1C		1A			RM	
Artemisia norvegica Fr. var. saxitalis (Besser) Jeps.		14A 1T 5C	5A 2T 4C		2A				RC	
Artemisia pattersonii A. Gray		3C	1A 4C					4A	R	SRxE-AE
Artemisia scopulorum A. Gray	1A	20A 10C	36A 3T 17C	14A 3T 5C	11A 3C	1A 1T		9A 4T	RM	
Chaenactis douglasii (Hook.) Hook. & Arn. var. alpina A. Gray			14A 2T 11C	5A 1T 1C	3A 1C				RM	
Cirsium clavatum (M. E. Jones) Petr. var. americanum (A. Gray) D.J. Keil		1A							R	
Cirsium eatonii (A. Gray) B.L. Rob. var. eriocephalum (A. Gray) D.J. Keil		3A 1T 2C	12A 14C	2C	9A 2T 2C	1A		3A 1T	R	SRxE
Cirsium parryi (A. Gray) Petr.			1A	2A					RM	
Cirsium scariosum Nutt.		4A	1A						RM	
Crepis nana Richardson		2C	5C			1A			RCM	
Crepis runcinata (E. James) Torr. & A. Gray subsp. runcinata					2A				RMA	
Dieteria bigelovii (A. Gray) D.R. Morgan & R.L. Hartm. var. bigelovii			2C		1A				RM	
Ericameria discoidea (Nutt.) G.L. Nesom			6A 2C		1A				RM	
Erigeron compositus Pursh		8A 2T 2C	14A 1T 8C	8A 1T 4C	3A	1A		1A	RCM	
Erigeron coulteri Porter		1A 1C	7A 4T 1C	3A 1T 4C	1A 1T			3A 1T	RM	
Erigeron elatior (A. Gray) Greene		1C	6A 2T 1C	4A 1C	1A				R	SRxE
Erigeron eximius Greene	1T		2A	1A	1A				RM	
Erigeron formossisimus Greene var. formossisimus			1A		4A				RM	
Erigeron formossisimus Greene var. viscidus (Rydb.) Cronquist			4A	2A		1A			RM	
Erigeron glacialis (Nutt.) A. Nelson var. glacialis	1A	9A 2T 3C	10A 3T 6C	9A 3T 3C	3A 1C	1T		1A 1T	RM	
Erigeron grandiflorus Hook.	1A	16A 1T 7C	35A 5T 20C	13A 2T 6C	14A 2T 3C	1A	1T	7A 2T	RM	

Table 2. (continued)

Subregions Family/Species	WY (n=1)	n CO (n=119)	c CO (n=98)	sw CO (n=40)	se CO (n=33)	UT (n=1)	AZ (n=1)	NM (n=14)	Floristic Region	Endemic
Erigeron humilis Graham			1C	1C					RC	
Erigeron lanatus Hook.			2C						R	SRxE-AE
Erigeron leiomerus A. Gray		13A	15A 2T 10C	6A 2T 1C	5A 1C				RM	
Erigeron mancus Rydb.[2]						1A			R	SRxE-AE
Erigeron melanocephalus (A. Nelson) A. Nelson	1A	16A 1T 4C	16A 8C	13A 4T 6C	6A 1C	1T		3A 1T	R	SRxE
Erigeron nivalis Nutt.	1A				1A				RC	
Erigeron pinnatisectus (A. Gray) A. Nelson	1A	22A 1T 4C	34A 6T 13C	19A 1T 3C	15A 3C			7A	R	
Erigeron subtrinervis Rydb. ex Porter & Britton			1A		1A 1T				RMA	
Erigeron ursinus D.C. Eaton		3A 1T 1C	7A 2T 4C		1A 1T				RM	
Erigeron vagus Payson			4A 7C	1A 1C	4A	1A			RM	
Erigeron vetensis Rydb.			1A	1A					R	
Helianthella parryi A. Gray					3A			4A 1T	RM	
Helianthella quinquenervis (Hook.) A. Gray		1A	2A 1C			1T			RM	
Heterotheca fulcrata (Greene) Shinners		1A 1T	1A			1A			RM	
Heterotheca pumila (Greene) Semple		1A 1C	15A 4T 5C	1A 1C	3A 1C			2A	R	SRxE
Hieracium triste Willd. ex Spreng.	1A	4A 2C	8A 5T 5C	1A 3C	5A			1A 1T	RC	
Hymenoxys brandegeei (Porter ex A. Gray) K.L. Parker					15A 7C			10A 1T	RM	
Hymenoxys grandiflora (Torr. & A. Gray ex A. Gray) K.L. Parker	1A	26A 8C	49A 4T 17C	20A 3T 5C	3A	1A		1A	R	
Hymenoxys hoopesii (A. Gray) Bierner		1T	2A 2T	8A 1T 1C	2A	1T			RM	
Oreochrysum parryi (A. Gray) Rydb.		3A 2T	3A 1T 1C	2A 1T 1C	1A 1T	1T			RM	
Packera cana (Hook.) W.A. Weber & Á. Löve		4A 1T 1C	12A 7C						RMA	
Packera crocata (Rydb.) W.A. Weber & Á. Löve		3C	6C	2C	1C				RM	
Packera dimorphophylla (Greene) W.A. Weber & Á. Löve var. dimorphophylla	1A	12A 1T 2C	17A 1T 8C	12A 1T 3C	3A				RM	
Packera fendleri (A. Gray) W.A. Weber & Á. Löve			1A 1C	3A 1T	1A				RM	
Packera franciscana (Greene) W.A. Weber and Á. Löve[3]							1A		R	SRxE-AE
Packera öodes (Rydb.) W.A. Weber				2C	1A				R	
Packera porteri (Greene) C. Jeffrey			1A 5C						R	AE
Packera streptanthifolia (Greene) W.A. Weber & Á. Löve		1A 1T	1C	2A	2A 1T			1A	RCM	
Packera tridenticulata (Rydb.) W.A. Weber & Á. Löve		1A	6A 1T	9A 2T	2A 1T				RMA	
Packera werneriifolia (A. Gray) W.A. Weber & Á. Löve		3A 2T 1C	21A 2T 15C	5A 1T 10C	11A 3C			1A	RM	
Pyrrocoma clementis Rydb. var. clementis			3A 1T 2C	2C					RM	
Pyrrocoma uniflora (Hook.) Greene var. uniflora			3A 4C						RM	
Saussurea weberi Hultén			6A 5C		1C				R	AE
Senecio amplectens A. Gray var. amplectens			9A 2T 3C	1A 2C	3A 1T 2C			4A	R	
Senecio amplectens A. Gray var. holmii (Greene) H.D. Harr.		9A 1T 2C	23A 3T 11C	8A 7C	14A 1C			6A 1T	RM	AE
Senecio atratus Greene		2A 1T 1C	10A 2T 3C	6A 1T 1C	8A 1T 1C	1A			RM	
Senecio bigelovii A. Gray var. hallii A. Gray			2A 1T	4A 2C	4A 1T 1C			1A 1T	RM	
Senecio crassulus A. Gray	1A	13A 1T 2C	24A 9T 5C	6A 1T 7C	2A	1A 1T		3A 1T	RM	

TABLE 2. (continued)

Subregions Family/Species	WY (n=1)	n CO (n=119)	c CO (n=98)	sw CO (n=40)	se CO (n=33)	UT (n=1)	AZ (n=1)	NM (n=14)	Floristic Region	Endemic
Senecio fremontii Torr. & A. Gray var. blitoides (Greene) Cronquist	1A	15A 1T 3C	22A 1T 12C	7A 2T 2C	8A 3C			4A 2T	R	SRxE
Senecio fremontii Torr. & A. Gray var. inexpectatus Cronquist[2]						1A			R	SRxE-AE
Senecio integerrimus Nutt. var. exaltatus (Nutt.) Cronquist			5A 1C						RM	
Senecio pudicus Greene			3A 1T		1C				RM	
Senecio soldanella A. Gray		3A	6A 8C	5A 1T 3C	5A			3A	R	SRxE
Senecio taraxacoides (A. Gray) Greene		3A 3C	2A 6C	1A	14A 4C			7A 2T	R	SRxE-AE
Senecio triangularis Hook.		3A 1C	7A 3T 1C	2A 2C	1A 1T				RCM	
Senecio wootonii Greene			1A 1T	1A			1A		RM	
Solidago multiradiata Aiton	1A	6A	2A 1T 1C	2A 1T 2C		1A 1T	1A 1T	1A	RCM	
Solidago nana Nutt.		1A	3A 1T		2A				RM	
Solidago simplex Kunth var. simplex	1A	13A 1T 3C	25A 1T 7C	2A 1T 2C	8A 1T 3C			9A 2T	RCMA	
Symphyotrichum foliaceum (Lindl. ex DC.) G.L. Nesom var. apricum (A. Gray) G.L. Nesom	1A	5A 1C	5A	1C					RM	
Symphyotrichum foliaceum (Lindl. ex DC.) G.L. Nesom var. parryi (D.C. Eaton) G.L. Nesom			2A 1T 1C	2A					RM	
Taraxacum ceratophorum (Ledeb.) DC.		2C	7A 9C	2C	6A 1T 1C			3A	RCM	
Taraxacum officinale Weber ex F.H. Wigg.		1A	12A 1T	3A 3C	1A 1T	1A 1T	1T	1A	exotic	
Taraxacum scopulorum (A. Gray) Rydb.	1A	2C	4A 7C	1A 1T 2C	1A 1T 1C			2A	RC	disjunct
Tetraneuris acaulis (Pursh) Greene var. caespitosa A. Nelson		5C	6A 1T 8C		10A 1T 4C			8A 1T	R	
Tonestus lyallii (A. Gray) A. Nelson		5A 2C	2C						R	
Tonestus pygmaeus (Torr. & A. Gray) A. Nelson	1A	14A 2C	25A 1T 17C	11A 5C	15A 2T 2C			9A 3T	R	
Townsendia eximia A. Gray					1A				RM	
Townsendia leptotes (A. Gray) Osterh.			4C						RM	
Townsendia rothrockii A. Gray ex Rothr.			3A 5C	1A 2C					R	SRxE
Tripleurospermum inodorum (L.) Sch. Bip.					1A				exotic	
Xanthisma coloradoense (A. Gray) D.R. Morgan & R.L. Hartm.[1]			1T 2C	2A 2C					R	SRxE
Betulaceae										
Betula glandulosa Michx.		1A 2C	4A						RC	
Boraginaceae										
Eritrichium nanum (Vill.) Schrad. ex Gaudin var. elongatum (Rydb.) Cronquist		1T	6A 4C	22A 19C	12A 1C	12A 2T 5C			8A	RC
Hydrophyllum fendleri (A. Gray) A. Heller var. fendleri					2A 1T				R	
Lithospermum ruderale Douglas ex Lehm.		1A							RM	
Mertensia alpina (Torr.) G. Don		1A	1A 1C	1A	1A 1C			2A	R	
Mertensia ciliata (E. James ex Torr.) G. Don var. ciliata	1T	4A 2T 1C	11A 3T 6C	6A 3T 5C	1A 1T	1T			RM	
Mertensia franciscana A. Heller			4A 3C	1A			1A 1T		RM	
Mertensia fusiformis Greene			1A	3A 1T					RM	
Mertensia oblongifolia (Nutt.) G. Don	1A	1A	3A 1T 4C	11A 1T 4C	4A				RM	
Mertensia viridis (A. Nelson) A. Nelson[4]	1A 11T	20A 1T 5C	35A 2T 23C	12A 2T 2C	21A 4C	1A		4A 1T	RM	

Table 2. (continued)

Subregions Family/Species	WY (n=1)	n CO (n=119)	c CO (n=98)	sw CO (n=40)	se CO (n=33)	UT (n=1)	AZ (n=1)	NM (n=14)	Floristic Region	Endemic
Myosotis alpestris F.W. Schmidt		11A 1T							RC	
Phacelia bakeri (Brand) J.F. Macbr.					3A 1C			4A	R	
Phacelia glandulifera Piper			1A						RM	
Phacelia glandulosa Nutt. var. glandulosa				1A					RM	
Phacelia hastata Douglas ex Lehm. var. hastata			5A 1T 1C		1A				RM	
Phacelia sericea (Graham ex Hook.) A. Gray var. ciliosa Rydb.		1A	9A 2T						RM	
Phacelia sericea (Graham ex Hook.) A. Gray var. sericea		14A 1T 2C	22A 2T 15C	19A 5T 3C	11A	1A		3A	R	
Brassicaceae										
Boechera drepanoloba (Greene) Windham & Al-Shehbaz			1A						R	
Boechera grahamii (Lehm.) Windham & Al-Shehbaz		1A	1A	1A 1T					RCA	
Boechera languida (Rollins) Windham & Al-Shehbaz			1A						R	
Boechera lemmonii (S. Watson) W.A. Weber			5A 5C	1A 2C					RM	
Boechera spatifolia (Rydb.) Windham & Al-Shehbaz		1A		1A					R	
Boechera stricta (Graham) Al-Shehbaz		6A 1T 2C	20A 9T 2C	8A 2T 3C	3A 1T 1C	1A 1T		1A 1T	RCMA	
Braya glabella Richardson subsp. glabella[1]			2C						RC	
Braya humilis (C. A. Mey.) B.L. Rob.			4C						RC	
Cardamine cordifolia A. Gray		3A 1T 2C	8A 1T 2C	7A 1T 2C	2A	1T			RM	
Cardamine oligosperma Nutt. var. oligosperma		1A							RM	
Descurainia incana Bernh. ex Fisch. & C.A. Mey.		1A	1A 1C	1A					RCMA	
Draba abajoensis Windham & Al-Shehbaz[2]						1T			RM	
Draba albertina Greene			1C	1A 1C					RCM	
Draba aurea Vahl ex Hornem.	1A	7A 3C	23A 3T 15C	9A 2T 5C	17A 1T 3C	1A	1A 1T	3A	RCMA	
Draba cana Rydb.	1A	4A 3C	7A 11C	1A 1T 1C	4A			3A	RCMA	
Draba crassa Rydb.		2A 2C	19A 14C	2A 4C	2A				R	
Draba crassifolia Graham	1A	5A 1T 4C	12A 3T 12C	13A 4T 3C	5A 2C	1A		3A	RCM	
Draba densifolia Nutt.	1A								RM	
Draba exunguiculata (O.E. Schulz) C.L. Hitchc.[1]			1A 5C						R	SRxE-AE
Draba fladnizensis Wulf.		2A 1C	8A 4C	1A 1C	10A 1C	1A			RC	disjunct
Draba globosa Payson			2C						RM	
Draba graminea Greene				4A 2C					R	SRxE-AE
Draba grayana (Rydb.) C.L. Hitchc.[1]		1A 2C	6A 5C		4A 3C			2A	R	SRxE-AE
Draba heilii Al-Shehbaz[5]								1A	R	SRxE-AE
Draba helleriana Greene				1A	1A			4A 1T	RM	
Draba incerta Payson			2A 1C						RCM	
Draba lonchocarpa Rydb.		3C	7A 18C						RCM	
Draba malpighiacea Windham & Al-Shehbaz				1C					R	SRxE
Draba oligosperma Hook.	1T		5A 2T 9C						RCM	
Draba porsildii G.A. Mulligan		1A 3C	2A 4C		2A				RC	

Table 2. (continued)

Subregions Family/Species	WY (n=1)	n CO (n=119)	c CO (n=98)	sw CO (n=40)	se CO (n=33)	UT (n=1)	AZ (n=1)	NM (n=14)	Floristic Region	Endemic
Draba smithii Gilg ex O.E. Schulz[1]				2A	1C				R	SRxE
Draba spectabilis Greene			6A 1T 2C	6A 3T 4C					R	
Draba streptobrachia R.A. Price			1A 5C	7A 1T 5C	4A 1C			1A	R	SRxE
Draba streptocarpa A. Gray		4A 7C	4A 3C	1A	8A 1T 1C			6A	R	
Draba ventosa A. Gray			2A 3C						R	
Erysimum capitatum (Douglas ex Hook.) Greene var. purshii (T. Durand) Rollins	1A	10A 1T 2C	23A 3T 18C	21A 3T 4C	16A			6A 1T	RCM	
Eutrema edwardsii R. Br.[3]			1A 5C						RC	disjunct
Noccaea fendleri (A. Gray) Holub ssp. glauca (A. Nelson) Al-Shehbaz and M. Koch	1A 11T	11A 1T 3C	27A 10T 11C	15A 6T 3C	21A 1C	1A 1T	1A	1A 1T	RM	
Physaria alpina Rollins			5A 1T 8C						R	SRxE-AE
Rorippa alpina (S. Watson) Rydb.		1A 1C	3A 1T 3C	1C					RM	
Rorippa curvipes Greene			1C	1A 1T 1C					RMA	
Smelowskia americana Rydb.		11A 1T 2C	34A 2T 16C	15A 1T 4C		1A			RM	
Campanulaceae										
Campanula parryi A. Gray var. parryi		1A	4A		1A				RM	
Campanula rotundifolia L.	1A	10A 1T 2C	16A 5T 9C	1A 3C	6A 1C			4A 1T	RCMA	
Campanula uniflora L.	1A	3A 6C	9A 13C	2A 2C	4A 1T 4C			2A	RC	
Caprifoliaceae										
Linnaea borealis L. var. longiflora Torr.			1C						RCMA	
Lonicera involucrata (Richardson) Banks ex Spreng. var. involucrata			2A 2T	1A 1T 3C	1A	1T			RMA	
Valeriana acutiloba Rydb. var. acutiloba		1C	9A 3T 11C	3A 1T	3A 2C				R	SRxE
Valeriana acutiloba Rydb. var. pubicarpa (Rydb.) Cronquist		4A 2T	1A 1T						RM	
Valeriana edulis Nutt. ex Torr. & A. Gray var. edulis		4A 1T 1C	10A 4T 1C	5A 1T 1C	5A 1C			1A 1T	RM	
Valeriana occidentalis A. Heller		1A 1C	1A	7A 3T	3A 1T				RM	
Caryophyllaceae										
Arenaria lanuginosa (Michx.) Rohrb. var. saxosa (A. Gray) Zarucchi, R.L. Hartm. & Rabeler			1C	2C			1T		RM	
Cerastium arvense L. ssp. strictum Gaudin	1A	12A 3C	26A 5T 8C	6A 2T	9A 1T 1C	1A 1T		5A 2T	RCMA	
Cerastium beeringianum Cham. & Schltdl.		8A 1C	16A 2T 12C	16A 3T 6C	13A 1T	1A 1T	1A 1T	4A	RCM	
Eremogone congesta (Nutt.) Ikonn. var. congesta		1A	13A 5T 2C						RM	
Eremogone fendleri (A. Gray) Ikonn.		19A 2T 3C	20A 1T 9C	8A 1T 4C	19A 1T 1C	1A 1T	1A	7A 3T	RM	
Eremogone kingii (S. Watson) Ikonn. var. glabrescens (S. Watson) Dorn						1A			RM	
Minuartia macrantha (Rydb.) House		1A	5A 1T 4C	3A 2T 6C			1A		RM	
Minuartia obtusiloba (Rydb.) House	1A	26A 1T 9C	36A 4T 16C	21A 3T 5C	24A 1T 4C	1A	1A	7A 2T	RCM	
Minuartia rubella (Wahlenb.) Hiern	1A	9A 2C	5A 1T 8C	2A 2C	9A 2C	1A	1A 1T	4A	RCM	
Minuartia stricta (Swartz) Hiern		1C	1A 5C	1C	1A				RC	disjunct
Paronychia pulvinata A. Gray	1A 11T	9A 3C	6A 11C	1A	3A 1C			6A	R	

Table 2. (continued)

Subregions Family/Species	WY (n=1)	n CO (n=119)	c CO (n=98)	sw CO (n=40)	se CO (n=33)	UT (n=1)	AZ (n=1)	NM (n=14)	Floristic Region	Endemic
Sagina caespitosa (J. Vahl) Lange ex Rink		4C	4C						RC	disjunct
Sagina saginoides (L.) H. Karst.		1C	1A 3C	1C		1T			RCM	
Silene acaulis (L.) Jacq.	1A 11T	25A 6C	42A 4T 16C	18A 4T 6C	19A 2C	1A	1A 1T	7A	RCM	
Silene drummondii Hook. var. drummondii		1A 1C	4A 1T 3C	2C	1A 1C				RMA	
Silene drummondii Hook. var. striata (Rydb.) Bocq.		7A	11A 3T	4A 4T	5A	1T			RM	
Silene hitchguirei Bocq.	1A	1A 3C	4A 10C		3A				R	AE
Silene kingii (S. Watson) Bocq.			1A						R	AE
Silene scouleri Hook. ssp. hallii (S. Watson) C.L. Hitchc. & Maguire		1A 2C	1A 6C						R	
Silene uralensis (Rupr.) Bocq. ssp. uralensis			1A 4C	2C					RC	
Stellaria calycantha (Ledeb.) Bong.			1A						RCM	
Stellaria irrigua Bunge			3C	3A 1T 6C	8A			4A	R	disjunct
Stellaria longipes Goldie ssp. longipes	1A	5A 3C	10A 1T 5C	4A 2C	6A 1T 1C	1A		1A 1T	RCMA	
Stellaria umbellata Turcz.		5A 4C	3A 1T 8C	3A 5C	8A			4A	RCM	
Crassulaceae										
Rhodiola integrifolia Raf. var. integrifolia	1A	6A 2C	38A 5T 8C	16A 3T 7C	22A			7A 2T	RCM	
Rhodiola rhodantha (A. Gray) H. Jacobsen	1A	11A 4C	18A 2T 4C	6A 2T 6C	3A 1T 2C		1A 1T	3A	RM	
Sedum lanceolatum Torr. var. lanceolatum	1A	12A 1T 3C	19A 4T 3C	3A 3C	8A	1A		7A 2T	RCMA	
Cyperaceae										
Carex albonigra Mack.	1A 11T	8A 7C	15A 2T 12C	14A 2T	10A 1T 2C	1A	1A 1T	4A	RCM	
Carex aquatilis Wahlenb. var. aquatilis		1C	5A 8C	6A 3T 1C					RCMA	
Carex arapahoensis Clokey		5C	2A 11C	1A 1C	1A 1T 2C	1A			R	
Carex atrosquama Mack.			1C	6A 1T 2C					RC	
Carex aurea Nutt.			1A 1C						RCMA	
Carex bella L.H. Bailey			1C	2A 3C	3A 1T 1C		1T		RM	
Carex brunnescens (Pers.) Poir. var. brunnescens		1A							RCM	
Carex canescens L. var. canescens			2A	1C					RCMA	
Carex capillaris L.		4C	3A 7C					2A	RCMA	
Carex capitata L.		1C	1A	1C					RC	disjunct
Carex chalciolepis T. Holm	1A	18A 1T 7C	23A 1T 22C	11A 3T 6C	10A 1T 5C	1A	1T	9A 1T	RM	
Carex ebenea Rydb.		6A 1T 4C	12A 3T 12C	9A 3T 7C	2A 2C		1A 1T	7A 1T	RM	
Carex elynoides T. Holm	1A	5A 6C	12A 2T 22C	17A 4T 3C	12A 3C	1A		7A	RM	
Carex engelmannii L.H. Bailey			3C						RM	
Carex epapillosa Mack.		1A 1C	5A 1T		3A				RM	
Carex fuliginosa Schkuhr		4C	8C	1C					RC	
Carex geyeri Boott			1C			1T			RM	
Carex gynocrates Wormsk. ex Drejer			1C						RCA	
Carex haydeniana Olney		2A 1T 4C	8A 10C	3A 2T 3C	2A			1A	RM	
Carex illota L.H. Bailey		2A 7C	1A 1T 6C	1A 2C					RM	

Table 2. (continued)

Subregions Family/Species	WY (n=1)	n CO (n=119)	c CO (n=98)	sw CO (n=40)	se CO (n=33)	UT (n=1)	AZ (n=1)	NM (n=14)	Floristic Region	Endemic
Carex incurviformis Mack.		2C	2A 6C						RC	
Carex jonesii L.H. Bailey			1C						RM	
Carex lachenalii Schkuhr	1A	5C	2A 4C	3C					RC	
Carex macloviana d'Urv.		1C	1A 1C						RC	
Carex magellanica Lam. subsp. irrigua (Wahlenb.) Britton, Sterns & Poggenb.				1C					RCA	
Carex microglochin Wahlenb. subsp. microglochin		2C	3C						RC	disjunct
Carex micropoda C.A. Mey.	1A 11T	11A 8C	7A 1T 9C	3A 4C	1A				RC	
Carex microptera Mack.	1A		2A 1T 1C	1A 1T				1A	RCM	
Carex nardina Fr.		1A 1C	5A 9C	1A 1C	3A			1A	RCM	
Carex nelsonii Mack.		4C	7A 10C	3A 1T 4C	1A 1C			2A	R	
Carex nigricans C.A. Mey.		4A 6C	3A 11C	1A 1T 6C	2A 1C				RC	
Carex nova L.H. Bailey	1A	1A 4C	6A 1T 5C	2A 3C	1A 2C	1A 1T		1A	RM	
Carex obtusata Lilj.		1C	2C	1C	1A 1C				RCA	
Carex pachystachya Cham. ex Steud.			1A 1C		1C				RCM	
Carex pelocarpa F.J. Herm.		1A 1C	1A 3C	3A 1T 1C	1A				RM	
Carex perglobosa Mack.		1A 5C	5A 13C	3A 1T 4C	1C				R	SRxE-AE
Carex petasata Dewey	1A								RCM	
Carex phaeocephala Piper	1A 11T	13A 3C	10A 2T 7C	4C	5A 1C	1A		4A	RM	
Carex pityophila Mack.								1A	RM	
Carex praticola Rydb.		1C	2A 1T						RCA	
Carex praeceptorum Mack.	1A 11T	1C	2C						RM	
Carex rossii Boott		2C	4C	1A 1T	1C	1A 1T			RCMA	
Carex rupestris All.	1A	4C	4A 15C		1A 2C			6A 1T	RC	
Carex saxatilis L.		3C	5C	4C					RC	
Carex scirpoidea Michx. var. pseudoscirpoidea (Rydb.) Cronquist			1A 3C	6C		1A 1T			RM	
Carex scopulorum T. Holm	1A	7A 2T 7C	9A 13C	1A 1T 1C	2A			2A	RM	
Carex siccata Dewey		1A 4C	8A 4T 7C		3A 1T 1C		1T	2A 1T	RCMA	
Carex stenoptila F. J. Herm.					2A 1T				R	
Carex stevenii (T. Holm) Kalela	1A	1A 2C	3C	1A					R	
Carex utriculata Boott		1T		3A 2C					RCMA	
Carex vernacula L.H. Bailey		6C	2C	1A 5C					R	
Eleocharis quinqueflora (Hartm.) O. Schwarz		3C	3C						RCMA	
Eriophorum angustifolium Honck. subsp. angustifolium			1A 2C						RCA	
Eriophorum scheuchzeri Hoppe			1A 1C	4C				2A	RC	
Kobresia myosuroides (Vill.) Fiori & Paoli		4C	6A 12C	2C	3A 5C			3A	RC	
Kobresia sibirica (Turcz. ex Ledeb.) Boeck.		1A 2C	2A 6C						RC	disjunct
Kobresia simpliciuscula (Wahlenb.) Mack.		3C	1A 4C						RC	

Table 2. (continued)

Subregions Family/Species	WY (n=1)	n CO (n=119)	c CO (n=98)	sw CO (n=40)	se CO (n=33)	UT (n=1)	AZ (n=1)	NM (n=14)	Floristic Region	Endemic
Ericaceae										
Arctostaphylos uva-ursi (L.) Spreng.	1T		3A 2T						RCMA	
Gaultheria humifusa (Graham) Rydb.		2A 2C		2C					R	
Kalmia microphylla (Hook.) A. Heller	1A 11T	4A 1T 4C	1C						RCM	
Moneses uniflora (L.) A. Gray			1C	1A 1T	1A 1T				RCMA	
Vaccinium cespitosum Michx.	1A	1A 1T 2C	2A 3T 1C	5A 2T 4C		1T			RCA	
Vaccinium myrtillus L.		2C	3A 1T 1C	2A 1T 4C	3A				RM	
Vaccinium scoparium Leiberg ex Coville	1A 11T	3A	2C		2A 1T			2A	RM	
Fabaceae										
Astragalus alpinus L. var. alpinus			6A 3C		1A 1T 2C				RCM	
Astragalus australis (L.) Lam. var. glabriusculus (Hook.) Isely			2C						RCMA	
Astragalus molybdenus Barneby[1]			3A 10C						R	SRxE-AE
Astragalus robbinsii (Oakes) A. Gray var. minor (Hook.) Barneby			5C						RC	
Hedysarum occidentale Greene			1C	1A 1C					RM	
Lupinus argenteus Pursh var. argenteus			2A						RM	
Lupinus argenteus Pursh var. laxiflorus (Douglas ex Lindl.) Dorn			5A						R	
Lupinus argenteus Pursh var. rubricaulis (Greene) S. L. Welsh			2A						RM	
Lupinus lepidus Douglas ex Lindl. var. utahensis (S. Watson) C.L. Hitchc.			1A						RM	
Oxytropis borealis DC. var. viscida (Nutt.) S.L. Welsh			2A 3C						RM	
Oxytropis campestris (L.) DC. var. cusickii (Greenm.) Barneby			1C						RM	
Oxytropis campestris (L.) DC. var. spicata Hook.					1A 1T 1C				RCA	
Oxytropis deflexa (Pall.) DC. var. deflexa			4A 6C	1C					RC	
Oxytropis deflexa (Pall.) DC. var. foliolosa (Hook.) Barneby			1A						RCM	
Oxytropis deflexa (Pall.) DC. var. sericea Torr. & A. Gray				1A					RCMA	
Oxytropis lambertii Pursh var. bigelovii A. Gray			1A						RMA	
Oxytropis parryi A. Gray		1A	1C		1A 1T 1C				RM	
Oxytropis podocarpa A. Gray			7A 9C	1C	1C				RC	disjunct
Oxytropis sericea Nutt. var. sericea			1A						RMA	
Oxytropis splendens Douglas ex Hook.			4A 1C		1A				RCA	
Trifolium attenuatum Greene			1C	11A 1T 6C	10A 5C			9A 1T	R	SRxE
Trifolium brandegeei S. Watson				2A 1T 2C				1A 1T	R	SRxE
Trifolium dasyphyllum Torr. & A. Gray	1A 11T	18A 2T 10C	33A 6T 14C	4A 1T 1C	14A 1T 2C	1A 1T		1A	R	
Trifolium nanum Torr.		7A 6C	18A 14C	13A 2T 3C	18A 1T 4C	1A		8A 1T	R	AE
Trifolium parryi A. Gray var. parryi	1A	13A 2T 5C	19A 3T 15C	10A 2T 4C	9A 1T 3C	1T		3A	R	
Trifolium repens L.				2A	1A				exotic	
Gentianaceae										
Frasera speciosa Douglas ex Griseb.		1A 1C	4A 1T 3C	1A	1A				RM	
Gentiana algida Pall.	1A	10A 4C	21A 1T 13C	2A 3C	5A 1T 2C			5A 1T	RC	disjunct

Table 2. (continued)

Subregions Family/Species	WY (n=1)	n CO (n=119)	c CO (n=98)	sw CO (n=40)	se CO (n=33)	UT (n=1)	AZ (n=1)	NM (n=14)	Floristic Region	Endemic
Gentiana bigelovii A. Gray								1A	RM	
Gentiana parryi A. Gray		5A 1T 5C	12A 2T 7C	2A 2C		1A		2A 1T	RM	
Gentiana prostrata Haenke		1A 3C	6A 10C	2A 5C	1A 3C			2A	RCM	
Gentianella amarella (L.) Boerner var. acuta (Michx.) Herder	1A	6A 6C	7A 9C	1A	5A 1T 2C		1T	2A	RCMA	
Gentianella amarella (L.) Boerner var. heterosepala (Engelm.) Dorn			6A 1T			1A			RM	
Gentianella tenella (Rottb.) Boerner		1C	2A 4C	3C				2A	RCM	
Gentianopsis barbellata (Engelm.) H.H. Iltis		2A 1C	4A 1T 2C	1C	1C			1A	RM	
Gentianopsis detonsa (Rottb.) Ma var. elegans (A. Nelson) N.H. Holmgren		1C	6A 2T 2C	2A 4C	1A				RM	
Swertia perennis L.		5A 1T 3C	9A 1T 7C	3A 2C	1A 2C				RM	
Geraniaceae										
Geranium richardsonii Fisch. & Trautv.		1C	2A 2T 1C	7A 2T					RM	
Grossulariaceae										
Ribes cereum Douglas var. cereum		1A 2T	4A 1T	3A 1T					RMA	
Ribes inerme Rydb. var. inerme			1A						RM	
Ribes lacustre (Pers.) Poir.	1A	1A							RCMA	
Ribes montigenum McClatchie	1A	3A 2T 1C	8A 9T 9C	10A 5T 3C	6A	1A 1T	1A 1T	3A	RM	
Ribes wolfii Rothr.			1A 1T 1C	2A 2T 1C				1A	RM	
Hydrangeaceae										
Jamesia americana Torr. & A. Gray var. americana			1A						RM	
Juncaceae										
Juncus arcticus Willd. var. balticus (Willd.) Trautv.			1A 1C						RCMA	
Juncus biglumis L.		3C	4C					2A	RC	disjunct
Juncus castaneus Sm.		4C	2A 3C		1C			3A	RC	
Juncus drummondii E. Mey.	1A	9A 1T 4C	20A 1T 13C	12A 6T 4C	2A 1C	1T		3A 1T	RM	
Juncus hallii Engelm.			1A						RM	
Juncus mertensianus Bong.		1A 2C	4A 1T 5C	3A 2T 4C	1C	1T			RM	
Juncus parryi Engelm.	1T	5A 2C	6A 3C	2A	2A			2A	RM	
Juncus triglumis L. var. albescens Lange			1A 5C					2A	RC	
Juncus triglumis L. var. triglumis		7C	1A 3C					1A	RC	disjunct
Luzula parviflora (Ehrh.) Desv.		1T 1C	4A 2T 1C	1A 1C	1A	1T		1A	RCM	
Luzula spicata (L.) DC.	1A	12A 6C	29A 5T 16C	12A 3T 4C	15A 1C	1A		11A 3T	RCM	
Luzula subcapitata (Rydb.) H.D. Harr.		2C	3A 7C	2C					R	SRxE
Liliaceae										
Allium cernuum Roth			1A						RMA	
Allium geyeri S. Watson var. geyeri		4C	1A 1T 2C	7A 3T 4C	8A	1T		2A 1T	RM	
Allium geyeri S. Watson var. tenerum M.E. Jones				3A					R	
Calochortus gunnisonii S. Watson var. gunnisonii					1A				RM	
Erythronium grandiflorum Pursh var. grandiflorum	1A 11T	1C	2C	1C					RM	

Table 2. (continued)

Subregions Family/Species	WY (n=1)	n CO (n=119)	c CO (n=98)	sw CO (n=40)	se CO (n=33)	UT (n=1)	AZ (n=1)	NM (n=14)	Floristic Region	Endemic
Lloydia serotina (L.) Rchb. var. serotina		1A 6C	18A 19C	9A 3T 5C	11A 1C			6A	RC	
Maianthemum racemosum (L.) Link var. amplexicaule (Nutt.) Dorn					1A				RM	
Veratrum californicum T. Durand				4A 2T 3C	1T				RM	
Zigadenus elegans Pursh		5A 2T 1C	18A 3T 6C	9A 2T 3C	12A 2C	1A 1T		4A 1T	RCMA	
Linaceae										
Linum lewisii Pursh var. lewisii			2A						RCMA	
Onagraceae										
Chamerion angustifolium (L.) Holub var. canescens (A.W. Wood) N.H. Holmgren & P.K. Holmgren		5A 1T 1C	8A 2T 3C	3A 1T 1C	1A			2A	RCMA	
Chamerion latifolium (L.) Holub		1A	5A 2C	1A 4C					RCM	
Epilobium anagallidifolium Lam.		4A 3C	3A 5C	7A 3C	1A				RCM	
Epilobium clavatum Trel.		4A 1C	2A 2C		1A				RM	
Epilobium halleanum Hausskn.		1A 1C	1A 1T						RM	
Epilobium hornemannii Rchb. var. hornemannii		3A 2C	3A 2C	1A 1C					RCM	
Epilobium saximontanum Hausskn.		1T 1C		2C	1T				RCM	
Oenothera cespitosa Nutt. var. macroglottis (Rydb.) Cronquist					1A				R	
Orchidaceae										
Platanthera aquilonis Sheviak			2A						RCA	
Platanthera stricta Lindl.					1T				R	
Papaveraceae										
Papaver radicatum Rottb. ssp. kluanensis (D. Löve) D.F. Murray		1A 3C	5A 13C	1A 2C	1A				R	AE
Parnassiaceae										
Parnassia fimbriata König var. fimbriata			2A 1C	1C					RCM	
Parnassia kotzebuei Cham. ex Spreng.[1]		2C	2C	1C					RC	
Plantaginaceae										
Plantago tweedyi A. Gray				2A 2T		1T			RM	
Plumbaginaceae										
Armeria maritima (Mill.) Willd. ssp. sibirica (Turcz. ex Boiss.) G.H.M. Lawr.[1]			1A 1C						RC	disjunct
Poaceae										
Achnatherum lettermanii (Vasey) Barkworth		5A 1T	1C	1A		1T			RM	
Achnatherum nelsonii (Scribn.) Barkworth ssp. dorei (Barkworth & J. Maze) Barkworth		1C	1A						RMA	
Agrostis mertensii Trin.	1A	2C	2A 3C	1C			1T		RCA	
Agrostis scabra Willd.	1A		2A 2T 1C	1C 1T 1C	1A 1C			1A 1T	RCMA	
Agrostis variabilis Rydb.	1A	1A 4C	1C	1A				3A	RM	
Alopecurus magellenicus Lam.		1C	4A						RC	
Alopecurus pratensis L.				2A					exotic	
Anthoxanthum hirtum (Schrank) Y. Schouten & Veldkamp			3C						RCMA	

Table 2. (continued)

Subregions Family/Species	WY (n=1)	n CO (n=119)	c CO (n=98)	sw CO (n=40)	se CO (n=33)	UT (n=1)	AZ (n=1)	NM (n=14)	Floristic Region	Endemic
Avenula hookeri (Scribn.) Holub			4C						RA	
Blepharoneuron tricholepis (Torr.) Nash					2A			2A	RMA	
Bromus ciliatus L.		1C			1C		1T		RCMA	
Bromus inermis Leyss.			1A						exotic	
Bromus porteri (J.M. Coult.) Nash			1A 1T		1T				RMA	
Bromus pumpellianus Scribn.			2A 1T 1C		1A 1C				RCA	
Calamagrostis canadensis (Michx.) P. Beauv.		1A 1T 2C	2A	2A 1T 1C	1C			1A	RCMA	
Calamagrostis purpurascens R. Br.	1A	4A 1T 4C	13A 8C	1C	4A 3C	1A		5A 1T	RCM	
Calamagrostis stricta (Timm) Koeler						1T			RCMA	
Danthonia intermedia Vasey		1A 1C	2A 1T 3C	1A	1A 1C		1T	2A 1T	RCM	
Danthonia parryi Scribn.			1C		1C			2A	RM	
Deschampsia cespitosa (L.) P. Beauv. var. cespitosa[6]	1A	14A 1T 4C	22A 3T 9C	11A 4T 4C	6A 1T 3C			7A 2T	RCMA	
Elymus bakeri (E.E. Nelson) Á. Löve				1A 1T				1A	RM	
Elymus scribneri (Vasey) M.E. Jones	1A	10A 1T 5C	26A 3T 11C	11A 1T 4C	17A 1T 4C	1A	1A	9A 2T	RM	
Elymus trachycaulus (Link) Gould ex Shinners ssp. trachycaulus		9A 1T 1C	17A 4T 8C	5A 1T 3C	2A 3T 2C	1A		1A	RCMA	
Elymus violaceus (Hornem.) Freilberg								5A	RCM	
Festuca baffinensis Polunin		1A 1C	3C						RC	
Festuca brachyphylla Schult. ex Schult. & Schult. f. var. coloradensis (Fred.) Dorn	1A 11T	8A 1T 2C	25A 3T 12C	10A 2T 5C	12A 1T 2C	1A	1A 1T	10A 2T	R	
Festuca earlei Rydb.		1A 1C	1A 1C						RM	
Festuca idahoensis Elmer			2A 4C	1C					RM	
Festuca minutiflora Rydb.	1A	4A 5C	10A 3T 4C	8A 1T 2C	7A			3A 1T	RM	AE
Festuca rubra L. ssp. rubra		2C	1A						exotic	
Festuca saximontana Rydb. var. purpusiana (St.-Yves) Fred. & Pavlick		1A	1A 1C	4A 1T 1C	3A				R	
Festuca saximontana Rydb. var. saximontana		4A 3C	4A 1T 5C	2A 1C	2A 3C			3A	RCMA	
Festuca thurberi Vasey			3T 3C	7A 2T 2C	2A 1C			2A	RM	
Helictotrichon mortonianum (Scribn.) Henard		2C	8A 10C		2A			1A	R	
Koeleria macrantha (Ledeb.) Schult.			1A						RCMA	
Phippsia algida (Phipps) R. Br.		1C	6C						RC	disjunct
Phleum alpinum L. var. alpinum	1A	8A 1T 4C	14A 3T 8C	15A 6T 4C	8A 1T 1C	1A	1A 1T	7A 1T	RCM	
Poa abbreviata R. Br. ssp. pattersonii (Vasey) Á. Löve, D. Löve, & B.M. Kapoor	1A	4A 3C	12A 6C	9A 1T	5A	1A			RC	AE
Poa alpina L. var. alpina	1A	8A 1T 4C	20A 3T 8C	15A 3T 6C	8A 1T 1C			3A	RCM	
Poa annua L.			1A						exotic	
Poa arctica R. Br. ssp. aperta (Scribn. & Merr.) Soreng			1A					1A	RM	
Poa arctica R. Br. ssp. arctica	1A	3A	5A	1A	1A				RC	
Poa arctica R. Br. ssp. grayana (Vasey) Á. Löve, D. Löve, & K.M. Kapoor	1A	3A 4C	18A 5T 11C	3A 3C	4A 1C			5A	R	AE
Poa arida Vasey			3A 1T	1A 1T	3A			1A	RA	
Poa cusickii Vasey subsp. pallida Soreng		3A		6A					RCM	

Table 2. (continued)

Subregions Family/Species	WY (n=1)	n CO (n=119)	c CO (n=98)	sw CO (n=40)	se CO (n=33)	UT (n=1)	AZ (n=1)	NM (n=14)	Floristic Region	Endemic
Poa cusickii Vasey var. epilis (Scribn.) C.L. Hitchc.	1A	6A 3C	14A 4T 5C	1A 1T 4C	1A				RMA	
Poa fendleriana (Steud.) Vasey		1A 1T 2C	10A 1T 6C	6A 1T 2C	4A 1T 2C	1A	1A	3A	RMA	
Poa glauca Vahl var. glauca			2A		2A	1A			RCMA	
Poa glauca Vahl var. rupicola (Nash ex Rydb.) B. Boivin	1A	7A 1T 4C	24A 1T 21C	9A 1T 5C	5A 5C	1A		8A 2T	RM	AE
Poa interior Rydb.		4A 3C	8A 1T 2C	3A 2T 2C	2A 1T 1C	1A	1A 1T	2A	RMA	
Poa leptocoma Trin.	1A	1C	2A 1T	1A 1C				1A	RCM	
Poa lettermanii Vasey		4C	1A 5C	5A	1C				RM	AE
Poa palustris L.		1A	1A						exotic	
Poa pratensis L. (except P. p. alpigena)		2A 1C	1C	4A	2A				exotic	
Poa pratensis L. ssp. alpigena (Lindm.) Hiitonen			2A						RCA	
Poa reflexa Vasey & Scribn.	1A 11T	2A 1T 4C	12A 1T 7C	1A 1C	2A	1A 1T	1T	2A	RM	
Poa secunda J. Presl ssp. juncifolia (Scribn.) Soreng					1C	1T			RMA	
Poa secunda J. Presl ssp. secunda	1A	9A 1T 3C	9A 7C	9A 3T	3A 1T				RMA	
Poa wheeleri Vasey		3A 1C	10A 4T 2C	1A 1T	1A	1A			RM	
Podagrostis humilis (Vasey) Bjoerkman		5C	4C		1A				RM	
Ptilagrostis porteri (Rydb.) W.A. Weber[1]			1C						R	SRxE
Trisetum montanum Vasey			1C		2A				R	
Trisetum spicatum (L.) K. Richt.	1A	22A 1T 6C	33A 4T 15C	18A 4T 6C	12A 1T 4C	1A 1T	1A 1T	8A 3T	RCMA	
Trisetum wolfii Vasey		1C							RM	
Vahlodea atropurpurea (Wahlenb.) Fr. ex Hartm.		2A 1C	1A 2C						RC	
Polemoniaceae										
Aliciella pinnatifida (Nutt. ex A. Gray) J.M. Porter			2A 1C	3A	1A 1C				RMA	
Aliciella sedifolia (Brandegee) J.M. Porter[1]				1A 2C					R	SRxE-AE
Ipomopsis spicata (Nutt.) V.E. Grant ssp. capitata (A. Gray) V.E. Grant			5A 6C						R	SRxE-AE
Leptosiphon nuttallii (A. Gray) J.M. Porter & L.A. Johnson ssp. nuttallii			1A		1C				RM	
Phlox condensata (A. Gray) E.E. Nelson			21A 3T 11C	7A 2C	14A 2C			2A 2T	RM	
Phlox pulvinata (Wherry) Cronquist	1T	2A 4C		11A 4T	7A			4A	RM	
Phlox vermejoensis Legler								1A	R	SRxE-AE
Polemonium brandegeei (A. Gray) Greene		3C	1C		1A				R	
Polemonium confertum A. Gray			18A 1T 6C	3A 1T 3C	1A 2C				R	SRxE
Polemonium pulcherrimum Hook. var. delicatum (Rydb.) Cronquist		5A 3T 2C	14A 8T 5C	10A 7T 2C	5A	1A 1T		1A 1T	RM	
Polemonium viscosum Nutt.	1A 11T	18A 2T 5C	28A 3T 13C	19A 5T 7C	23A 1C	1A	1A 1T	7A	RM	
Polygonaceae										
Bistorta bistortoides (Pursh) Small	1A 11T	19A 1T 5C	33A 8T 13C	17A 6T 5C	12A 2T			5A 1T	RM	
Bistorta vivipara (L.) Delarbre	1A	5A 2C	15A 1T 11C	6A 3T 4C	13A 4C	1A		5A	RCMA	
Eriogonum arcuatum Greene var. xanthum (Small) Reveal		4A 2C	8A 1T 8C		1A 1T 2C			3A	R	SRxE
Eriogonum coloradense Small			1A 1C						R	SRxE
Eriogonum flavum Nutt. var. flavum					3A				RA	

Table 2. (continued)

Subregions Family/Species	WY (n=1)	n CO (n=119)	c CO (n=98)	sw CO (n=40)	se CO (n=33)	UT (n=1)	AZ (n=1)	NM (n=14)	Floristic Region	Endemic
Eriogonum umbellatum Torr. var. aureum (Gand.) Reveal		1T	5A						RM	
Eriogonum umbellatum Torr. var. majus Hook.		1A	3A 2T 2C						RM	
Koenigia islandica L.		7C	3C						RC	
Oxyria digyna (L.) Hill	1A 11T	22A 1T 3C	25A 1T 10C	12A 2T 5C	15A 1T 3C	1A	1A 1T	5A 1T	RCMA	
Polygonum aviculare L.				2A					exotic	
Polygonum douglasii Greene		2C	1C	1A 1T	1A				RMA	
Rumex acetosella L.					1A				exotic	
Rumex densiflorus Osterh.			1C	1C					R	
Rumex utahensis Rech. f.			1A						RM	
Portulacaceae										
Claytonia lanceolata Pursh		1C	1A 2C						RM	
Claytonia megarhiza (A. Gray) Parry ex S Watson		8A 1C	35A 3T 17C	18A 4T 7C	19A	1A		6A 1T	RM	
Lewisia pygmaea (A. Gray) B.L. Rob.		5A 1T 4C	16A 4T 4C	9A 3T 4C	4A	1T		3A	RM	
Lewisia rediviva Pursh var. rediviva			1A						RM	
Primulaceae										
Androsace chamaejasme Wulfen ssp. lehmanniana (Spreng.) Hultén[2]		2C	2A 3C		16A 6C	1A		8A 1T	RC	
Androsace septentrionalis L.		17A 4T 2C	21A 5T 8C	17A 5T 7C	15A	1A 1T	1A	6A 1T	RCMA	
Dodecatheon pulchellum (Raf.) Merrill var. pulchellum					4A			3A	RCMA	
Primula augustifolia Torr.		4C	13A 1T 12C		15A 1T 3C			7A 1T	R	SRxE-AE
Primula parryi A. Gray		7A 1T 3C	16A 9C	9A 2T 4C	6A 1C		1A		RM	
Ranunculaceae										
Aconitum columbianum Nutt. ssp. columbianum		1A 1T	4A 1T 2C	4A 1C					RM	
Actaea rubra (Aiton) Willd.		1C			1A				RCMA	
Anemone multifida Poir. var. multifida		3A 1T	14A 4T 3C	2A 2C	1A				RCM	
Anemone multifida Poir. var. stylosa (A. Nelson) B.E. Dutton & Keener		1T 1C				1A	1A 1T		RM	
Anemone narcissiflora L. var. zephyra (A. Nelson) B.E. Dutton & Keener		7A 1C	22A 2T 11C						R	
Anemone parviflora Michx.			3A 3C						RC	
Anemone patens L. var. multifida Pritz.	1A	3A 3C	7A 2T						RCA	
Aquilegia chrysantha A. Gray							1T		RM	
Aquilegia coerulea E. James var. coerulea	1A 11T	15A 1T 1C	28A 5T 5C	14A 5T 5C	12A			3A	R	SRxE
Aquilegia elegantula Greene			1A 1T						RM	
Aquilegia saximontana Rydb.		3C	5C						R	SRxE
Aquilegia scopulorum Tidest.				1A					RM	
Caltha leptosepala DC.	1A	11A 2T 4C	19A 3T 6C	14A 4T 2C	10A 1C			4A	RM	
Delphinium alpestre Rydb.[5]			3A 2C		4A 2C			4A	R	SRxE-AE
Delphinium barbeyi (Huth) Huth		1A 2C	6A 2T 2C	2A 1T 2C					RM	
Delphinium ramosum Rydb.					2A				R	
Ranunculus abortivus L.	1A								RA	

Table 2. (continued)

Subregions Family/Species	WY (n=1)	n CO (n=119)	c CO (n=98)	sw CO (n=40)	se CO (n=33)	UT (n=1)	AZ (n=1)	NM (n=14)	Floristic Region	Endemic
Ranunculus adoneus A. Gray		16A 3T 5C	12A 2T 9C						RM	
Ranunculus alismifolius Geyer ex Benth. var. montanus S. Watson		4A 2T 1C	3C	8A 4T 5C					RM	
Ranunculus eschscholtzii Schltdl.	1A	4A 1T	3A 1T 4C	1A 2C					RC	
Ranunculus gelidus Kar. & Kir.			6C						RC	
Ranunculus hyperboreus Rottb.			2A						RC	
Ranunculus inamoenus Greene var. inamoenus		1A 1T 1C	4A 2T 3C	3A 1T 2C	1A 1C				RM	
Ranunculus inamoenus Greene var. subaffinis (A. Gray) L.D. Benson							1T		R	SRxE
Ranunculus macauleyi A. Gray		1A	3A 2C	14A 2T 4C	11A 3C			8A 2T	R	SRxE
Ranunculus pedatifidus Sm. var. affinis (R. Br.) L.D. Benson		1A 2C	4A 1T 5C	5A 1T	5A		1A		RCA	
Ranunculus pygmaeus Wahlenb.		2C	1A 4C						RC	
Thalictrum alpinum L.		1A 1C	7A 8C	2A 2C	7A 1C			3A	RCM	
Trollius albiflorus (A. Gray) Rydb.	1A	2A 2T 5C	5A 1T 6C	3A 1T 4C	1A				R	
Rosaceae										
Dasiphora fruticosa (L.) Rydb.	1A	2A	19A 5T 3C	3A 1T	12A			4A	RCMA	
Dryas hookeriana Juz.		9A 5C	18A 4T 9C	2A 1C	2A 4C				RC	
Drymocallis glabrata Rydb.			1A 1T						RM	
Fragaria vesca L.					1A 1T				RCM	
Fragaria virginiana Mill.		1A 1T 1C	6A 2T 2C	5A 3T	1A	1T			RCMA	
Geum macrophyllum Willd. var. perincisum (Rydb.) Raup				3A					RCM	
Geum rossii (R. Br.) Ser. var. turbinatum (Rydb.) C.L. Hitchc.	1A 11T	31A 1T 11C	47A 4T 18C	19A 3T 5C	25A 2T 1C	1A	1A 1T	8A 1T	RM	
Geum triflorum Pursh var. ciliatum (Pursh) Fassett		1A	2A 1T	3A 1T					RM	
Geum triflorum Pursh var. triflorum			2A						RA	
Holodiscus dumosus (Nutt. ex Hook.) A. Heller		1T			1A			1A 1T	RM	
Ivesia gordonii (Hook.) Torr. & A. Gray		5A	4A 2C	1C	1A 1C				RM	
Petrophyton caespitosum (Nutt.) Rydb.		1A							RM	
Potentilla concinna Richardson var. concinna		6A 2T 1C	2A 1T 3C	3A 1T 2C	5A 1T 1C			6A 1T	RMA	
Potentilla diversifolia Lehm. var. diversifolia	1A 11T	23A 3T 5C	26A 6T 18C	19A 5T 5C	10A 1T 1C	1A	1A 1T	4A 1T	RM	
Potentilla gracilis Douglas ex Hook. var. fastigiata (Nutt.) S. Watson		1A	2A	2A					RM	
Potentilla gracilis Douglas ex Hook. var. pulcherrima (Lehm.) Fernald		4A 1C	7A 3T 1C	3A 2T 4C	5A 1T	1A 1T		3A	RM	
Potentilla hippiana Lehm. var. hippiana		2A	1A	1A					RMA	
Potentilla hookeriana Lehm.	1A 11T	7A 5C	6A 14C	11A 3C	7A	1A	1A	1A	RM	
Potentilla modesta Rydb.	1A								RM	
Potentilla ovina Macoun var. ovina		1A 1C	1A 1T 10C		1C	1A			RM	
Potentilla paucijuga Rydb.						1A			R	SRxE
Potentilla pensylvanica L.		3A 1T	3A		1A 1C	1A			RCM	
Potentilla plattensis Nutt.		1A			1A				RCMA	
Potentilla saximontana Rydb.	1A	6A 2T 1C	13A 1T 7C	8A 1T 1C	12A 1T	1A			R	SRxE-AE
Potentilla subjuga Rydb.	1A	3A 1C	7A 2T 13C	5A 1T 1C	6A 1T 2C			3A	R	

Table 2. (continued)

Subregions Family/Species	WY (n=1)	n CO (n=119)	c CO (n=98)	sw CO (n=40)	se CO (n=33)	UT (n=1)	AZ (n=1)	NM (n=14)	Floristic Region	Endemic
Potentilla uniflora Ledeb.		3A 3C	4A 8C	1A	4A				RC	
Rubus idaeus L. var. aculeatissimus Regel & Tiling		3A 1T	2A 1C	1A	1A			1A1T	RCMA	
Sibbaldia procumbens L.	1A 11T	17A 3T 5C	29A 4T 12C	18A 6T 6C	15A 1C	1A 1T	1A	9A 3T	RCM	
Rubiaceae										
Galium boreale L.					1A				RCMA	
Salicaceae										
Populus tremuloides Michx.		1C	1A 1T						RCMA	
Salix arctica Pall. var. petraea (Andersson) Bebb	1A	12A 7C	22A 2T 15C	13A 1T 3C	4A 1C			5A 1T	RM	
Salix brachycarpa Nutt. var. brachycarpa	1A 11T	6A 6C	15A 2T 12C	7A 4T 6C	6A 1T 1C				RCM	
Salix calcicola Fernald & Wiegand			2C						RC	disjunct
Salix cascadensis Cockerell	1A 11T	1A							R	disjunct
Salix glauca L. var. villosa Andersson	1A 11T	10A 1T 4C	12A 5T 3C	3A 1C	2A				RC	
Salix monticola Bebb		1A	1A						RM	
Salix planifolia Pursh	1A 11T	6A 5C	11A 2T 8C	9A 3T 4C	2A 1C			2A	RCMA	
Salix reticulata L. var. nana Andersson		10A 7C	19A 5T 8C	18A 6T 5C	12A 1T 3C	1A		5A	RM	
Saxifragaceae										
Chrysosplenium tetrandrum (Lund ex Malmgren) Th. Fr.		3C	3C						RC	disjunct
Heuchera bracteata (Torr.) Ser.		3A 1C	1A						R	SRxE
Heuchera hallii A. Gray			1A						R	SRxE
Heuchera parvifolia Nutt. ex Torr. & A. Gray		7A 6C	25A 4T 16C	11A 4T 4C	20A 1T 4C			7A 1T	RM	
Heuchera rubescens Torr. var. versicolor (Greene) M.G. Stewart							1A 1T		RM	
Micranthes foliolosa (R. Br.) Gornall			2C						RC	disjunct
Micranthes odontoloma (Piper) A. Heller			1A						RM	
Micranthes oregana (Howell) Small			7A 1T 3C		1A				RM	disjunct
Micranthes rhomboidea (Greene) Small	1A 11T	10A 1T 4C	32A 6T 14C	21A 4T 4C	17A 1C	1A 1T	1A	6A 1T	RM	
Saxifraga adscendens L.		3C	2A 6C	5C					RCM	
Saxifraga bronchialis L. var. austromontana (Wiegand) Piper ex G.N. Jones		14A 1T 2C	20A 4T 5C	6A 3T 3C	14A 1C	1A		8A 1T	R	
Saxifraga cernua L.		2A 2C	9A 9C	6C	8A 1T 2C			4A	RCMA	
Saxifraga cespitosa L.		5A 2C	7A 11C	2A 3C	9A 3C	1A		2A	RCM	
Saxifraga chrysantha A. Gray	1A	4A 6C	10A 10C	1A 1C	6A 3C			4A	R	
Saxifraga debilis Engelm. ex A. Gray		2A 4C	4A 1T 6C	5A 1T 6C	5A 1C	1T	1A	3A	R	
Saxifraga flagellaris Willd. ex Sternb.var. crandallii (Gand.) Dorn		3A 3C	11A 15C	8A 1T 3C	14A 2C		1A 1T	6A	RM	
Saxifraga hirculus L.			2C						RC	
Telesonix jamesii (Torr.) Rafinesque.			1C						R	SRxE
Scrophulariaceae										
Besseya alpina (A. Gray) Rydb.[7]	1A	5A 2C	23A 1T 14C	12A 1T 3C	15A 2C	1A		8A 1T	R	SRxE-AE
Besseya plantaginea (E. James) Rydb.		1A	2A		2A				R	
Besseya ritteriana (Eastw.) Rydb.				1A 1T 2C					R	SRxE
Castilleja haydenii (A. Gray) Cockerell				5A 3C	15A 6C			10A 1T	R	SRxE-AE

Table 2. (continued)

Subregions Family/Species	WY (n=1)	n CO (n=119)	c CO (n=98)	sw CO (n=40)	se CO (n=33)	UT (n=1)	AZ (n=1)	NM (n=14)	Floristic Region	Endemic
Castilleja miniata Douglas ex Hook. var. miniata		5A 1T 1C	7A 1T	9A 5T	2A				RCM	
Castilleja occidentalis Torr.		25A 2T 7C	48A 5T 17C	15A 4T 5C	16A 5C	1A 1T		8A 2T	R	
Castilleja puberula Rydb.		4C	2C						R	SRxE
Castilleja rhexifolia Rydb.		11A 1T 5C	18A 2T 10C	11A 3T 4C				1A	RM	
Castilleja sulphurea Rydb.		5A	8A 1T 1C	4A 1T	3A 2T 1C	1A			RM	
Chionophila jamesii Benth.	1A 11T	5A 7C	13A 12C	7A 1T 4C	7A 1T 2C			5A	R	SRxE-AE
Mimulus guttatus DC.		3A 2C	2C	5A 3C	1A 1T				RCM	
Pedicularis bracteosa Benth. var. paysoniana (Pennell) Cronquist		2A 2C	6A 2T 1C	4A 1T 1C					R	
Pedicularis groenlandica Retz.	1A	10A 1T 2C	20A 2T 4C	12A 3T 4C	7A 1T 3C			3A	RCM	
Pedicularis parryi A. Gray var. mogollonica (Greene) Dorn				8A 1T	1A				RM	
Pedicularis parryi A. Gray var. parryi	1A	9A 1T 5C	30A 6T 13C	4A 2T 4C	11A 7C		1A 1T	5A	RM	
Pedicularis procera A. Gray		1A	1A						RM	
Pedicularis racemosa Douglas ex Benth. var. alba (Pennell) Cronquist		1A 1C	3A 3T 1C	3A 3T 1C	1A				RM	
Pedicularis sudetica Willd. ssp. scopulorum (A. Gray) Hultén		3C	7A 9C	4A 1T 2C	1A 1C			2A	R	SRxE
Penstemon crandallii A. Nelson ssp. crandallii				1A					R	
Penstemon hallii A. Gray		1C	11A 1T 13C	7A 3C	2A 2C				R	SRxE
Penstemon harbourii A. Gray		1A 1C	5A 1T 6C	7A 1T 4C	1A 1C				R	SRxE-AE
Penstemon procerus Douglas ex Graham var. procerus		3A 1C	1A						RM	
Penstemon rydbergii A. Nelson			1C						RM	
Penstemon saxosorum Pennell		1A	1T						R	
Penstemon whippleanus A. Gray	1A 11T	22A 1T 4C	26A 7T 14C	12A 4T 4C	12A 2C	1A	1A 1T	6A	RM	
Veronica wormskjoldii Roem. & Schult.	1A	9A 5C	16A 1T 8C	12A 4T 5C	4A 1T 4C	1T		4A	RCMA	
Urticaceae										
Urtica dioica L. subsp. gracilis (Aiton) Selander		1C			1A				RCA	
Urtica dioica L. subsp. holosericea (Nutt.) Thorne					1A				RM	
Violaceae										
Viola adunca Sm.		1A 2T		2A 2T				3A	RCMA	
Viola biflora L.		4C	1C		1A 2C				RC	disjunct
Viola labradorica Schrank		3A 1C	6A 2T 4C	6A 1T 5C	4A 1C				RCA	disjunct
Viola palustris L.		1A							RCM	
Viola praemorsa Douglas ex Lindl.		1T	1A 1T						RM	

[1] USFS Sensitive Colorado
[2] USFS Sensitive Utah
[3] ESA listed Threatened
[4] may include M. lanceolata (Pursh) DC at treeline
[5] USFS Sensitive New Mexico
[6] may include *D. brevifolia* R.Br.
[7] USFS Sensitive Wyoming

represent approximately half of the species richness of larger mountain systems. Future synthesis of the Middle Rockies floristic inventories at the RM may clarify the discrepancy between the Scott (1995) and Hadley (1987) estimates, but our results seem to fit the broader alpine pattern.

The checklist (Table 2) is based on vouchered specimens and should be most useful to botanists and land managers determining what taxa are likely to occur within their area of interest. The frequency values within Table 2 are best interpreted as relative probabilities for within taxon comparisons between subregions or between alpine meadow and treeline ectotone areas within the alpine zone of a subregion. Relative probability of occurrence between taxa should be limited to small discrete areas of interest. The overall lower number of occurrences within the treeline ecotone probably reflects its relative narrowness compared to more expansive alpine meadow and talus slopes. We caution against over interpretation of the frequency counts. Some taxa with a high number of occurrences, such as *Achillea millefolia* and *Cymopterus lemmonii*, are common in lower elevation habitats as well as in the alpine zone. Other high occurrence taxa, such as *Geum rossii*, are predominantly alpine zone species. Similarly, a low number of occurrences could indicate taxa that infrequently range up to the treeline ecotone, taxa that are narrowly distributed geographically, or prominent tree species that are less often collected.

The levels of endemism and floristic region distribution (Table 2) provide a convenient synthesis of the best available knowledge for botanists and biodiversity managers that recommend TES designations based on geographic distribution. Most of the U.S. Forest Service Sensitive species (Table 2) have some level of endemism within the Southern Rockies. The 25 taxa endemic to the alpine zone of the Southern Rockies would also make a key set of biogeographic/population ecology/species migration studies for the effects of future climate change and possible species loss.

ACKNOWLEDGMENTS

We are indebted to the graduate students from our program in covering alpine areas in their studies. We thank Tim Hogan, COLO, for making their database available and Josh Irwin for preparing Figure 1. Salary support for this manuscript was provided by the Rocky Mountain Herbarium and by the Forest and Woodlands Ecosystems Program, Rocky Mountain Research Station, U.S. Forest Service. We thank Walter Fertig and an anonymous reviewer for their contribution to this paper.

REFERENCES

Allred, K.W. & R.D. Ivey. 2012. Flora Neomexicana III: An illustrated identification manual. Lulu Press Inc., Raleigh, North Carolina, U.S.A.

Arnett, M. 2002. A floristic inventory of the southern Gunnison Basin and the southeastern Uncompahgre Plateau, Colorado. MS thesis, Dept. Botany, Univ. Wyoming, Laramie, U.S.A.

Arno, S.F. & R.P. Hammerly. 1984. Timberline, mountain and arctic forest frontiers. The Mountaineers, Seattle, Washington, U.S.A.

Baars, D.L. 1983. The Colorado Plateau, a geological history. Univ. of New Mexico Press, Albuquerque, U.S.A.

Billings, W.D. 2000. Alpine vegetation. In: North American terrestrial vegetation, 2nd edition, M.G. Barbour and W.D. Billings, eds. Cambridge Univ. Press, England. Pp. 537–572.

Blakey, R. & W. Ranney. 2008. Ancient Landscapes of the Colorado Plateau. Grand Canyon Assoc., Grand Canyon, Arizona, U.S.A.

Brouillet, L. & R.D. Whetstone. 1993. Climate and Physiography. In: Flora of North America Editorial Committee, eds. Flora of North America north of Mexico. Oxford Univ. Press, New York, U.S.A. 1:15–46.

Brummer, L. 2014. A floristic study of the Gunnison National Forest and Montrose Basin. MS thesis in prep., Dept. Botany, Univ. Wyoming, Laramie, U.S.A.

Chapin, S.F. III & C. Körner. 1994. Arctic and alpine biodiversity: patterns, causes and ecosystem consequences. Trends Ecol. Evol. 9:45–47.

Chumley, T. 1998. A floristic survey of the east slope, central Colorado. MS thesis, Dept. Botany, Univ. Wyoming, Laramie, U.S.A.

Crimmins, S.M., S.Z. Dobrowski, J.A. Greenberg, J.T. Abutzoglou, & A.R. Mynsberge. 2011. Changes in climatic water balance drive downhill shifts in plant species' optimum elevations. Science 331:324–327.

Cronquist, A., N.H. Holmgren, & P.K. Holmgren. 1997. Intermountain flora: Vascular plants of the Intermountain West., U.S.A. Vol. 3. Subclass Rosidae (except Fabales). The New York Botanical Garden, Bronx, U.S.A.

Cronquist, A., A.H. Holmgren, N.H. Holmgren, & J.L. Reveal. 1972. Intermountain flora: Vascular plants of the Intermountain West., U.S.A. Vol. 1. Geological and Botanical History of the Region, its Plant Geography and a Glossary. The Vascular Cryptogams and the Gymnosperms. Hafner Publ. Co., New York, U.S.A.

Cronquist, A., A.H. Holmgren, N.H. Holmgren, J.L. Reveal, & P.K. Holmgren. 1977. Intermountain flora: Vascular plants of the Intermountain West., U.S.A. Vol. 6. The Monocotyledons. The New York Botanical Garden, Bronx, U.S.A.

Cronquist, A., A.H. Holmgren, N.H. Holmgren, J.L. Reveal, & P.K. Holmgren. 1989. Intermountain flora: Vascular plants of the Intermountain West., U.S.A. Vol. 3, Part B. Fabales. The New York Botanical Garden, Bronx, U.S.A.

Cronquist, A., A.H. Holmgren, N.H. Holmgren, J.L. Reveal, & P.K. Holmgren. 1984. Intermountain flora: Vascular plants of the Intermountain West., U.S.A. Vol. 4. Subclass Asteridae [except Asteraceae]. The New York Botanical Garden, Bronx, U.S.A.

Cronquist, A., A.H. Holmgren, N.H. Holmgren, J.L. Reveal, & P.K. Holmgren. 1994. Intermountain flora: Vascular plants of the Intermountain West., U.S.A. Vol. 5 [Asterales by A. Cronquist]. The New York Botanical Garden, Bronx, U.S.A.

Dorn, R.D. 2001. Vascular plants of Wyoming, 3rd edition. Mountain West Publ., Cheyenne, Wyoming, U.S.A.

Dorn, R.D. 2010. The genus *Salix* in North America north of Mexico. Published by the author, Lingle, Wyoming, U.S.A.

Elliott, B.S. 2000. A vascular flora of south-central Colorado. MS thesis, Dept. Botany, Univ. Wyoming, Laramie, U.S.A.

Flaig, J.H. 2007. A vascular plant inventory of the eastern San Juan Mountains and vicinity in southern Colorado. MS thesis, Dept. Botany, Univ. Wyoming, Laramie, U.S.A.

Flora of North America Editorial Committee, eds. 1993+. Flora of North America north of Mexico. 15+ vols. Oxford University Press. New York and Oxford, U.S.A & UK.

Foley, E.K. 2006. A floristic inventory of the Arapaho National Forest and Bureau of Land Management Lands in Grand County, Colorado. MS thesis, Dept. Botany, Univ. Wyoming, Laramie, U.S.A.

Grabherr, G., M. Gottfried, & H. Pauli.1994. Climate effects on mountain plants. Nature 369:448.

Hadley, K.S. 1987. Vascular alpine plant distribution within the central and southern Rocky Mountains, U.S.A. Arctic Alpine Res. 19:242–251.

Hartman, E.L. & M.L. Rottman. 1987. Alpine vascular flora of the Ruby Range, West Elk Mountains, Colorado. Great Basin Naturalist 47:152–160.

Hartman, R.L. 1992. The Rocky Mountain Herbarium, associated floristic inventory, and the Flora of the Rocky Mountains project. J. Idaho Acad. Sci. 28:22–43.

Holmgren, N.H., P.K. Holmgren, & A. Cronquist. 2005. Intermountain flora: Vascular plants of the Intermountain West., U.S.A. Vol. 2, Part B. Subclass Dilleniidae. The New York Botanical Garden, Bronx, U.S.A.

Holmgren, N.H., J.L. Reveal, & P.K. Holmgren, & Collaborators. 2012. Intermountain flora: Vascular plants of the Intermountain West., U.S.A. Vol. 2 Part A. Subclasses Magnoliidae-Caryophyllidae. The New York Botanical Garden Press, Bronx, U.S.A.

Holt, E.A. 2002. Vascular flora of the Sawatch, west Mosquito, and west Gore Ranges and Castle Peak Area, Colorado. MS thesis, Dept. Botany, Univ. Wyoming, Laramie, U.S.A.

Hunt, C.B. 1974. Natural regions of the United States and Canada. W.H. Freeman & Co. Ltd., San Francisco, U.S.A.

Johnson, P.L. & W.D. Billings. 1962. The alpine vegetation of the Beartooth Plateau in relation to cryopedogenic processes and patterns. Ecol. Monogr. 32:105–135.

Kastning, N. 1990. A floristic survey of the Park and Sierra Madre Ranges, Colorado and Wyoming. Dept. Botany, Univ. Wyoming, Laramie, U.S.A.

Kirkpatrick, M. 2014. A floristic inventory of the White River National Forest south of the Colorado River. MS thesis in prep., Dept. Botany, Univ. Wyoming, Laramie, U.S.A.

Körner, C. 1998. A re-assessment of high elevation treeline positions and their explanation. Oecologia 115:445–459.

Körner, C. 2003. Alpine plant life, functional plant ecology of high mountain ecosystems, 2nd ed. Springer-Verlag, Berlin, Germany.

Larson, J.E. 2008. A floristic inventory of vascular plants of the Carson National Forest and vicinity, north-central New Mexico, M.S. thesis, Dept. Botany, Univ. Wyoming, Laramie, U.S.A.

Legler, B.S. 2010. A floristic inventory of Vermejo Park Ranch, New Mexico and Colorado. MS thesis, Dept. Botany, Univ. Wyoming, Laramie, U.S.A.

Little, E.L. 1947. Alpine flora of San Francisco Mountain, Arizona. Madroño 6:35–81.

Lukas, L.D., B.E. Nelson, & R.L. Hartman 2012. A floristic inventory of vascular plants of the Medicine Bow National Forest and vicinity, southeastern Wyoming, U.S.A. J. Bot. Res. Inst. Texas 6:759–787.

Lyon, M.J. 1996. A floristic survey of the San Miguel and Lower Dolores River Drainage, Colorado and Utah. MS thesis, Dept. Botany, Univ. Wyoming, Laramie, U.S.A.

Marr, J.W. 1967. Ecosystems of the east slope of the Front Range in Colorado. Univ. of Colorado Studies, Ser. Biol., No. 9, Univ. of Colorado Press, Boulder, U.S.A.

Moore, L.M. 1998. Floristics of the Upper Dolores River Drainage, southwestern Colorado. MS thesis, Dept. Botany, Univ. Wyoming, Laramie, U.S.A.

Nations, D. & E. Stump. 1981. Geology of Arizona. Kendall/Hunt Pub. Co., Dubuque, Iowa, U.S.A.

Nelson, B.E. 1974. Vascular plants of the Medicine Bow Mountain, Wyoming. M.S. thesis, Dept. Botany, Univ. Wyoming, Laramie, U.S.A.

Nelson, B.E. 1984. Vascular plants of the Medicine Bow Range, revised edition. Jelm Mountain Press. Laramie, Wyoming, U.S.A.

Nunn, S.C. 2003. A vascular flora of the Canyon Lakes Ranger District of Roosevelt National Forest, Larimer County and adjacent areas, Colorado. MS thesis, Dept. of Biol. Sciences., Univ. of Arkansas, Fayetteville, U.S.A.

Pauli, H., M. Gottfried, S. Dullinger, & 29 others. 2012. Recent plant diversity changes on Europe's mountain summits. Science 336:353–355.

Rief, B.P. 2006. A vascular plant inventory of the Santa Fe National Forest (including the Valles Caldera National Preserve) and vicinity, north-central New Mexico. M.S. thesis, Dept. Botany, Univ. Wyoming, Laramie, U.S.A.

Rundel, P.W., A.C. Gibson, & M.R. Sharifi. 2008. The alpine flora of the White Mountains, California. Madroño 55:2002–215.

Schaak, C.G. 1983. The alpine vascular flora of Arizona. Madroño 30:79–88.

Scott, R.W. 1995. The alpine flora of the Rocky Mountains: Volume 1. The Middle Rockies. Univ. of Utah Press, Salt Lake City, U.S.A.

Spence, J.R. & R.J. Shaw. 1981. A checklist of the alpine vascular flora of the Teton Range, Wyoming, with notes on biology and habitat preferences. Great Basin Naturalist 41:232–242.

Taylor, K. 2000. A floristic inventory of the northern Gunnison Basin, Colorado. MS thesis, Dept. Botany, Univ. Wyoming, Laramie, U.S.A.

Theurillat, J-P. & A. Guisan. 2001. Potential impact of climate change on vegetation in the European Alps: a review. Climatic Change 50:77–109.

Thorne, R.F. 1993. Phytogeography. In: Flora of North America Editorial Committee, eds. Flora of North America north of Mexico. Oxford Univ. Press, New York, U.S.A. 1:132–153.

Vanderhorst, J.P. 1993. Flora of the Flat Tops, White River Plateau, and vicinity in northwestern Colorado. MS thesis, Dept. Botany, Univ. Wyoming, Laramie, U.S.A.

Weber, W.A. & R.C. Wittmann. 2012. Colorado flora. Western Slope: a field guide to the vascular plants, 4th ed. Univ. Press of Colorado, Boulder, U.S.A.

THE FIRST NATURALIZED OCCURRENCE OF THE CANNACEAE FAMILY IN THE ARKANSAS (U.S.A.) FLORA, WITH ADDITIONAL NEW AND NOTEWORTHY ANGIOSPERM RECORDS FOR THE STATE

Brett E. Serviss

Department of Biology
Henderson State University
Arkadelphia, Arkansas 71999–0001, U.S.A.
servisb@hsu.edu

James H. Peck

P. O. Box 705
Cedar Key, Florida 32625, U.S.A.
jhpeck@ualr.edu

Tiffany A. Graves

Department of Biology
Henderson State University
Arkadelphia, Arkansas 71999–0001, U.S.A.
TR180094@reddies.hsu.edu

ABSTRACT

Two species of monocotyledonous angiosperms, *Canna indica* L. and *Miscanthus sinensis* Anderss., are reported as new for Arkansas. The *Canna indica* record is the first documentation of the Cannaceae family in the state's flora outside of cultivation. Two additional species of angiosperms, *Deutzia scabra* L. and *Miscanthus sacchariflorus* (Maxim.) Hack., are documented for only their second occurrences in the state.

RESUMEN

Se dan como nuevas para Arkansas dos especies de monocotiledóneas, *Canna indica* L. y *Miscanthus sinensis* Anderss. La cita de *Canna indica* es la primera documentada de la familia Cannaceae para la flora del estado fuera de cultivo. Dos especies adicionales de angiospermas, *Deutzia scabra* L. y *Miscanthus sacchariflorus* (Maxim.) Hack., se documentan como segundas occurrencias en el estado.

INTRODUCTION

The Cannaceae, or canna family, is a group of monocotyledonous angiosperms represented by a single genus, *Canna*, and about 10 species of perennial, rhizomatous herbs, principally distributed over subtropical and tropical regions of the Americas. The precise native range of the genus, however, is difficult to determine, as many species of *Canna* are, at present, distributed over subtropical and tropical regions worldwide (Kress & Prince 2000; Wu & Kress 2000). Species of *Canna* are important as ornamentals for their showy, colorful flowers, large foliage leaves, and ease of cultivation. The U.S. flora boasts two native species of *Canna*, *C. flaccida* Salisb. and *C. glauca* L., along with the well-naturalized introduction, *C. indica* L. Other *Canna* species and hybrid taxa have been introduced via the horticultural trade, and along with the aforementioned species, are frequently cultivated in the southeastern U.S., including Arkansas (Bailey 1949; Bailey & Bailey 1976; Kress & Prince 2000). *Canna* species reproduce by seed and/or via vegetative/clonal reproduction from an extensive rhizome system. Vegetative reproduction can generate entire colonies of plants, allowing rapid establishment of populations, persistence long after cessation of cultivation practices, and potential spread and naturalization from areas of cultivation. Additionally, seeds or rhizome fragments can also be dispersed through natural or anthropogenic means, potentially resulting in the establishment of remote escaped populations. The origin of the *Canna indica* population in Arkansas is not known; however, plants were apparently not persisting from cultivation and were observed spreading at the site, where both reproductively mature and smaller plants were present.

Though documented outside of cultivation in several southeastern states, and sometimes cultivated in Arkansas, our discovery of *C. indica* represents the first occurrence of the Cannaceae family outside of cultivation in the state (Kress & Prince 2000; Arkansas Vascular Flora Committee 006; Gentry et al. 2013; SDA, NRCS 2014).

ADDITIONS TO THE ARKANSAS FLORA

Canna indica L. (Cannaceae), Indian shot. *Canna indica* is a perennial, rhizomatous herb that is considered to be native to the neotropics, although its precise native range is obscure. At present, it is widely cultivated and naturalized throughout the subtropics and tropics (Kress & Prince 2000; Wu & Kress 2000). *Canna indica* is also well-established in the U.S. flora from eastern Texas and Louisiana to Florida and the Carolinas (Kress & Prince 2000; USDA, NRCS 2014). In addition to ornamental use, *C. indica* is sometimes grown for its edible rhizomes which are rich in starch (Bailey 1949; Wu & Kress 2000).

Voucher specimen: **ARKANSAS. Pulaski Co.:** a few scattered plants with flowers, escaped and "seeding" in other plants—some plants smaller, Boyle Park vicinity, Cantrell Hill, wooded bluff and ravine above park, deciduous forest, Little Rock, 12 Sep 2002, *Peck 2002110* (HEND).

Miscanthus sinensis Anderss. (Poaceae), Maiden grass; Chinese silvergrass. *Miscanthus sinensis* is a caespitose perennial that is native to China, Japan, and Korea (Hitchcock 1950; Barkworth 2003; Chen & Renvoize 2006). It is naturalized over much of the eastern U.S. from Louisiana, Missouri, and Illinois to New York southward to Florida. It has also been documented from California and Colorado (Barkworth 2003; USDA, NRCS 2014). *Miscanthus sinensis* is readily available through the horticultural trade, frequently encountered in cultivation, and has become invasive in several states (Barkworth 2003; Smith 2008; Quinn et al. 2010; Meyer 2011). The origin of the Garland County plant of *M. sinensis* is unknown, but no other plants of *M. sinensis* were observed in the vicinity, nor was there any evidence of cultivation. The plant was well-established and thriving when discovered.

Voucher specimen: **ARKANSAS. Garland Co.:** one plant along roadside, Hwy. 70 E of Hot Springs near bypass, 3 Nov 2006, *Peck 06-777* (HEND).

SECOND OCCURRENCES IN THE ARKANSAS FLORA

Deutzia scabra L. (Hydrangeaceae), Roughleaf deutzia. *Deutzia scabra* is a deciduous, scandent shrub that is native to China and Japan (Bailey 1949). It is naturalized in the eastern U.S. from Illinois westward to New York and Vermont, and southward to North Carolina. It has also been documented from Utah and Florida (USDA, NRCS 2014). *Deutzia scabra* has only previously been documented in Arkansas from Garland County.

Voucher specimen: **ARKANSAS. Clark Co.:** several scandent shrubs from less than 1 m to more than 3 m (a few climbing into the lower canopy) growing along banks of Mill Creek, semi-wooded riparian zone, University Drive and Hwy. 7/67, Arkadelphia, 19 Sep 2013, *Serviss 8049* (HEND).

Miscanthus sacchariflorus (Maxim.) Hack. (Poaceae), Amur silvergrass. *Miscanthus sacchariflorus* is a rhizomatous perennial that is native to China, Japan, Korea, and Russia (Hitchcock 1950; Barkworth 2003; Chen & Renvoize 2006). It is naturalized in the north central and northeastern U.S. from western Nebraska and Missouri to Minnesota, New York, and Connecticut (Barkworth 2003; USDA, NRCS 2014). *Miscanthus sacchariflorus* has only previously been documented in Arkansas from Prairie County.

Voucher specimen: **ARKANSAS. Garland Co.:** a few plants along shoreline, south shoreline of Lake Hamilton near Andrew Hulsey State Fish Hatchery, 20 Oct 2006, *Peck 06-726* (HEND).

KEY TO ARKANSAS SPECIES OF *MISCANTHUS*

Miscanthus sacchariflorus and *M. sinensis* are morphologically similar, but can be distinguished using the following key.

1. Spikelets prominently awned; trichomes of callus about as long as spikelet _____ **M. sinensis**
1. Spikelets generally lacking awns; trichomes of callus about two times longer than spikelet _____ **M. sacchariflorus**

ACKNOWLEDGMENTS

We sincerely thank Brent Baker (Arkansas Natural Heritage Commission) and Barney Lipscomb (Botanical Research Institute of Texas) for their helpful comments and suggestions regarding this paper. We also thank

the Henderson State University Biology Department and the University of Arkansas at Little Rock Biology Department for supporting this work.

REFERENCES

Arkansas Vascular Flora Committee. 2006. Checklist of the vascular plants of Arkansas. Arkansas Vascular Flora Committee. Fayetteville, Arkansas, U.S.A.

Bailey, L.H. 1949. Manual of cultivated plants most commonly grown in the continental United States and Canada, Revised Edition. MacMillan Company, New York, New York, U.S.A.

Bailey, L.H. & E.Z. Bailey. 1976. Hortus Third: A concise dictionary of plants cultivated in the United States and Canada. Vol. 2. MacMillan Company, New York, New York, U.S.A.

Barkworth, M.E. 2003. *Miscanthus*. In: Flora of North America Editorial Committee, eds. 1993+. Flora of North America north of Mexico. 16+ vols. Oxford University Press, New York, U.S.A., and Oxford, U.K. 25:616–620.

Chen, S. & S.A. Renvoize. 2006. *Miscanthus*. In: Flora of China Editorial Committee, eds. 2003. Flora of China. Vol. 22 (Poaceae). Science Press, Beijing, China, and Missouri Botanical Garden Press, St. Louis, Missouri, U.S.A. Pp. 581–583.

Gentry, J.L., G.P. Johnson, B.T. Baker, C.T. Witsell, & J.D. Ogle, eds. 2013. Atlas of the vascular plants of Arkansas. University of Arkansas Herbarium. Fayetteville, Arkansas, U.S.A.

Hitchcock, A.S. 1950. Manual of the grasses of the United States. Second Edition revised by Agnes Chase. Miscellaneous Publication No. 200. U.S. Government Printing Office, Washington, D.C., U.S.A.

Kress, W.J. & L.M. Prince. 2000. Cannaceae. In: Flora of North America Editorial Committee, eds. 1993+. Flora of North America north of Mexico. 16+ vols. Oxford University Press, New York, U.S.A., and Oxford, U.K. 22:310–314.

Meyer, M. 2011. *Miscanthus*: Ornamental and invasive grass. (http://miscanthus.cfans.umn.edu/default.htm, Accessed on 24 Apr 2014.). University of Minnesota, St. Paul, Minnesota, U.S.A.

Quinn, L.D., D.J. Allen, & J.R. Stewart. 2010. Invasiveness potential of *Miscanthus sinensis*: Implications for bioenergy production in the U.S. GCB Bioenergy 2:310–320.

Smith, C. 2008. Invasive exotic plants of North Carolina. North Carolina Department of Transportation, Raleigh, North Carolina, U.S.A.

USDA, NRCS. 2014. The PLANTS Database (http://plants.usda.gov, Accessed on 23 Apr 2014.). National Plant Data Team, Greensboro, North Carolina, U.S.A.

Wu, D. & W.J. Kress. 2000. Cannaceae. In: Flora of China Editorial Committee, eds. 2003. Flora of China. Vol. 24 (Flagellariaceae through Marantaceae). Science Press, Beijing, China, and Missouri Botanical Garden Press, St. Louis, Missouri, U.S.A. P. 378.

JOURNAL NOTICE

Neal K. Van Alfen, Jan E. Leach, and Steven Lindlow, eds. 2014 (Aug). **Annual Review of Phytopathology, Volume 52.** (ISSN: 0066-4286; ISBN: 978-0-8243-1352-4, hbk). Annual Reviews, Inc., 4139 El Camino Way, P.O. Box 10139, Palo Alto, California 94303, U.S.A. (**Orders:** www.AnnualReviews.org, science@annualreviews.org, 1-800-523-8635, 1-650-493-4400). $96.00 indiv., 614 pp., 7.5" × 9.25".

ABOUT THIS JOURNAL—The *Annual Review of Phytopathology,* in publication since 1963, covers the significant developments in the field of plant pathology, including plant disease diagnosis, pathogens, host-pathogen Interactions, epidemiology and ecology, breeding for resistance and plant disease management, and includes a special section on the development of concepts.

Contents of Volume 52:

1. How Way Leads on to Way—*Isaac Barash*
2. Harnessing Population Genomics to Understand How Bacterial Pathogens Emerge, Adapt to Crop Hosts, and Disseminate—*Boris A. Vinatzer, Caroline L. Monteil, and Christopher R. Clarke*
3. New Insights into Mycoviruses and Exploration for the Biological Control of Crop Fungal Diseases—*Jiatao Xie and Daohong Jiang*
4. Altering the Cell Wall and Its Impact on Plant Disease: From Forage to Bioenergy—*Qiao Zhao and Richard A. Dixon*
5. Network Modeling to Understand Plant Immunity—*Oliver Windram, Christopher A. Penfold, and Katherine J. Denby*
6. The Role of Trees in Agroecology and Sustainable Agriculture in the Tropics—*Roger R.B. Leakey*
7. Plant-Parasitic Nematode Infections in Rice: Molecular and Cellular Insights—*Tina Kyndt, Diana Fernandez, and Godelieve Gheysen*
8. Mechanisms of Nutrient Acquisition and Utilization During Fungal Infections of Leaves—*Jessie Fernandez, Margarita Marroquin-Guzman, and Richard A. Wilson*
9. Governing Principles Can Guide Fungicide-Resistance Management Tactics—*Frank van den Bosch, Richard Oliver, Femke van den Berg, and Neil Paveley*
10. Virus Infection Cycle Events Coupled to RNA Replication—*Pooja Saxena and George P. Lomonossoff*
11. Novel Insights into Rice Innate Immunity Against Bacterial and Fungal Pathogens—*Wende Liu, Jinling Liu, Lindsay Triplett, Jan E. Leach, and Guo-Liang Wang*
12. The Activation and Suppression of Plant Innate Immunity by Parasitic Nematodes—*Aska Goverse and Geert Smant*
13. Protein Kinases in Plant-Pathogenic Fungi: Conserved Regulators of Infection—*David Turrà, David Segorbe, and Antonio Di Pietro*
14. Speciation in Fungal and Oomycete Plant Pathogens—*Silvia Restrepo, Javier F. Tabima, Maria F. Mideros, Niklaus J. Grünwald, and Daniel R. Matute*
15. The ABCs and 123s of Bacterial Secretion Systems in Plant Pathogenesis—*Jeff H. Chang, Darrell Desveaux, and Allison L. Creason*
16. Induced Systemic Resistance by Beneficial Microbes—*Corné M.J. Pieterse, Christos Zamioudis, Roeland L. Berendsen, David M. Weller, Saskia C.M. Van Wees, and Peter A.H.M. Bakker*
17. Fifty Years Since Silent Spring—*Lynn Epstein*
18. Localizing Viruses in Their Insect Vectors—*Stéphane Blanc, Martin Drucker, and Marilyne Uzest*
19. Plant Cell Wall-Degrading Enzymes and Their Secretion in Plant-Pathogenic Fungi—*Christian P. Kubicek, Trevor L. Starr, and N. Louise Glass*
20. Meta-Analysis and Other Approaches for Synthesizing Structured and Unstructured Data in Plant Pathology—*H. Scherm, C.S. Thomas, K.A. Garrett, and J.M. Olsen*
21. Networks and Plant Disease Management: Concepts and Applications—*M.W. Shaw and M. Pautasso*
22. Small RNAs: A New Paradigm in Plant-Microbe Interactions—*Arne Weiberg, Ming Wang, Marschal Bellinger, and Hailing Jin*
23. Predisposition in Plant Disease: Exploiting the Nexus in Abiotic and Biotic Stress Perception and Response—*Richard M. Bostock, Matthew F. Pye, and Tatiana V. Roubtsova*
24. Susceptibility Genes 101: How to Be a Good Host—*Chris C.N. van Schie and Frank L.W. Takken*
25. Horizontal Gene Transfer in Eukaryotic Plant Pathogens—*Darren Soanes and Thomas A. Richards*

AMERICAN MISTLETOE (*PHORADENDRON LEUCARPUM* SSP. *LEUCARPUM*, VISCACEAE) OCCURRENCE IN HOST TREES WITHIN THE CITY OF CAIRO, ALEXANDER COUNTY, ILLINOIS, AND ITS INCIDENCE IN ILLINOIS, U.S.A.

Ralph L. Thompson

Hancock Biological Station, Murray State University
Murray, Kentucky 42701, U.S.A.
Botanical Research Institute of Texas
1700 University Drive, Fort Worth, Texas 76107, U.S.A.
Berea College Herbarium, Biology Program
Berea College
Berea, Kentucky 40404, U.S.A.

ABSTRACT

A comprehensive survey of American mistletoe [*Phoradendron leucarpum* (Raf.) Reveal & M.C. Johnston ssp. *leucarpum*, Viscaceae] occurrence in host trees was conducted within the incorporated city limits of Cairo, Illinois, from 2011–2013. An extensive herbaria search for Illinois mistletoe specimens was completed in 2012, and a mistletoe reconnaissance was also made in 2013 to verify its present occurrence within 14 southern Illinois counties. Cairo, a historic river city and the county seat of Alexander County, is the southernmost city in Illinois, near the confluence of the Ohio and Mississippi Rivers. In Cairo, *Phoradendron leucarpum* ssp. *leucarpum* was observed in 547 host trees among 13 tree species (9 native, 4 introduced exotics). The two predominate host trees documented were *Acer saccharinum* (304 trees) and *Ulmus americana* (111 trees). The mistletoe occurrence value of Cairo is 13.41 host trees per km, the highest incidence of American mistletoe and greatest number of host species for a city of its size in Illinois. A statewide assessment of 19 southern Illinois counties resulted in 225 mistletoe specimens examined: 52 specimens collected in Cairo, 97 annotated from herbarium searches, and 76 additional specimens collected during the 14 county mistletoe host tree survey. Twenty-one host tree species were documented among those herbarium specimens. The top three host tree species by Illinois counties were *Ulmus americana* (16), *Acer saccharinum* (8), and *Nyssa sylvatica* (8). New North American mistletoe host trees documented were *Acer palmatum*, *Betula utilis* ssp. *jacquemontii*, and *Styphnolobium japonicum*. Duration of low winter temperatures has been the determining factor in the northern extension of mistletoe in southern Illinois over time.

Key Words: American mistletoe, distribution, host trees, mistletoe occurrence, *Phoradendron leucarpum* ssp. *leucarpum*, Viscaceae, Cairo, Alexander County, Illinois counties

RESUMEN

Un estudio exhaustivo de la ocurrencia de muérdago americano [*Phoradendron leucarpum* (Raf.) Reveal & MC Johnston ssp. *leucarpum*, Viscaceae] en los árboles hospedadores se llevó a cabo dentro de los límites incorporados de la ciudad de Cairo, Illinois, entre 2011-2013. Se completó una extensa búsqueda para especímenes de herbario de muérdago de Illinois en 2012, y también se hizo un reconocimiento secundario de muérdago en 2013 para verificar su ocurrencia actual en 14 condados del sur de Illinois. Cairo, una ciudad ribereña histórica vieja y el asiento del Condado de Alexander, es la ciudad más meridional de Illinois, cerca de la confluencia de los ríos Ohio y Mississippi. *Phoradendron leucarpum* ssp. *leucarpum* se observó en 547 árboles huéspedes entre 13 especies de árboles (9 nativas, 4 exóticas introducidas). En Cairo, los dos árboles hospedadores predominante documentados eran *Acer saccharinum* (304 árboles) y *Ulmus americana* (111 árboles). El valor ocurrencia de muérdago de Cairo es 13.41 árboles hospedadores por km, la mayor incidencia de muérdago americano y el mayor número de especies huéspedes para un área de su tamaño en Illinois. Una evaluación del estado resultó en 225 especímenes de muérdago examinados: 52 muestras recogidas en Cairo, 97 anotadas en la búsqueda de herbario, y 76 ejemplares adicionales recogidos durante una encuesta de los árboles huéspedes de muérdago en los condados del sur de Illinois. Veintiún especies de árboles de acogida diferentes fueron documentados de esos especímenes de herbario en 19 condados del sur de Illinois. Las tres principales especies de árboles hospedadores por condados de Illinois eran *Ulmus americana* (16), *Acer saccharinum* (8), y *Nyssa sylvatica* (8).

Palabras Clave: muérdago americano, distribución, árboles hospederos, presencia de muérdago, *Phoradendron leucarpum* ssp. *leucarpum,* Viscaceae, Cairo, condado de Alexander, condados de Illinois

INTRODUCTION

A survey of the incidence of *Phoradendron leucarpum* ssp. *leucarpum* (Viscaceae), herein, American mistletoe or mistletoe, in host trees within Cairo was conducted from March–December 2011, June 2012, and March–

April 2013. This Cairo survey is the first comprehensive American mistletoe survey for any Illinois town, city, or county.

Cairo, a famous historic river city in Alexander County, Illinois, was chosen as an excellent survey site for American mistletoe. This decision was made following preliminary reconnaissance in March 14, 2010, which revealed several species of mistletoe-infested host trees within the incorporated city boundary (Fig. 1). A comparable investigation of host trees infested with American mistletoe was recently completed for the historically significant city of Berea, Kentucky (Thompson et al. 2008).

While documenting mistletoe in Cairo, it also became evident little was known regarding the statewide distribution of this taxon. To conduct a complete study of American mistletoe for Cairo and the state of Illinois, a second essential objective of this study was to annotate the incidence of mistletoe documented by Illinois herbarium specimens. Fourteen state, regional, private, and major herbaria were surveyed for Illinois mistletoe specimens. All available mistletoe herbarium specimens from Illinois were examined to gather data on distribution in Illinois counties, collectors, dates, and host tree specificity through time. A third objective was to make a reconnaissance in 14 southern Illinois counties to currently document incidence of mistletoe-infested host trees.

AMERICAN MISTLETOE BIOLOGY

Reveal and Johnston (1957) established *Phoradendron leucarpum* (Raf.) Reveal & M.C. Johnston as the nomenclaturally correct name for American mistletoe. Abbott and Thompson (2011) made new combinations for three subspecific taxa within *P. leucarpum*, of which *P. leucarpum* ssp. *leucarpum* is the only infraspecific taxon native to the eastern United States.

American mistletoe is an epiphytic, dioecious, obligate hemiparasite on numerous deciduous host species in the eastern United States. This evergreen shrub is characterized by aerial shoots with opposite, simple, oval to ovate, coriaceous leaves, small spikes of tiny staminate and pistillate flowers on separate plants, and viscid, pearl-white, translucent one-seeded globular berries (Kuijt 1982, 2003; Fig. 2).

The principal dispersal agents of mistletoe fruits and seeds are avian vectors (Kuijt 2003). Birds spread mistletoe by ingesting the berries, defecating on branches, dislodging fruits, and wiping bills and feet during feeding, perching, and roosting (Thompson & Poindexter 2005; Thompson et al. 2008). The availability of host trees and birds are two important variables; moreover, the Mississippi Flyway corridor, which extends from upper Canada through Illinois to the Gulf Coast into South America, constitutes one of the most important flight pathways for bird travel and migration in the eastern United States. Nearly 50 percent of the 700–900 bird species in North America spend at least part of their lives in the Mississippi Flyway (Audubon 2013). Mistletoe has a clumped or aggregated spatial distribution pattern characteristic of ornithophily (Thompson & Noe, Jr. 2003; Thompson & Poindexter 2005).

In his *Monograph of Phoradendron*, Kuijt (2003) mapped the distribution range of American mistletoe [as: *Phoradendron serotinum* (Raf.) M.C. Johnston ssp. *serotinum*]. Its geographical range extends from New Jersey and Maryland southward through all Atlantic and Gulf Coastal States westward to central Texas, northeast Oklahoma, southeastern Kansas, east to Arkansas and Tennessee, southern Missouri, Illinois, Indiana, and Ohio, throughout Kentucky to west-central West Virginia and southern Pennsylvania. The geographical range of *Phoradendron leucarpum* ssp. *leucarpum* in the southeastern United States is southern intraneous (Thompson & Jones 2001) based on the geographical affinity model of Cain (1930). The geographical affinity of American mistletoe in southern Illinois is southern extraneous with its northernmost distribution limits primarily within a 160 km radius of the Mississippi Gulf Coastal Plain Province.

Winter climate is the determining factor of the northernmost extension of American mistletoe. Several botanists have reported the controlling factor on the northern distribution limits of mistletoe as low and prolonged winter freezing temperatures, e.g., Illinois (Schneck 1884a, b), Indiana (Deam 1932), Ohio (Spooner 1983), and Kentucky (Garman 1913; Thompson 2005). Coder (2008) reported climatic limits were the controlling features of the distributional range of American mistletoe and assessed the northern boundary to be

Fig. 1. Cairo incorporated city limits (red-lined boundary) in southern Alexander County near confluence of the Ohio and Mississippi Rivers.

Fig. 2. Pistillate clump of American mistletoe (*Phoradendron leucarpum* ssp. *leucarpum*) in Callery pear (*Pyrus calleryana*).

determined by the December minimum daily temperature being greater than -4.0°C. She also considered that the western edge of mistletoe was bounded by areas with a mean greater than 63.5 cm annual precipitation. Spooner (1983) determined the principal limiting factor of the northern expansion of mistletoe was directly correlated with the -4.5°C January mean minimum isotherm. He specifically mentioned that one of two exceptions to this isotherm was along the Wabash River Valley in southern Illinois. At this location, microclimates exist that are not incorporated into the gross climatological data. In southern Illinois, the northern range of American mistletoe lies within USDA Plant Hardiness Zone 6b (-17.78°C to -20.56°C) temperature range (USDA, ARS 2013).

CAIRO: THE STUDY SITE

History

Cairo, the southernmost city in Illinois and the county seat of Alexander County, served as an important steamboat port for cargo and commerce to New Orleans in the 19th century. The city is situated on a near level peninsula surrounded entirely by levees just north of Fort Defiance Park at the junction of the Ohio and Mississippi Rivers (Fig. 1). The Mississippi River is the largest river in discharge flow at its mouth and the Ohio River is the third largest river in discharge flow at its mouth in the United States (Kammerer 1990). Fort Defiance Park, a Union campsite and fort during the American Civil War, represents the southernmost land border within the Cairo Corporate Boundary and the lowest elevation in Illinois at 84 m above sea level (asl).

The first Europeans to discover the junction of the Ohio and Mississippi Rivers were the French Jesuit Jacques Marquette and explorer Louis Jolliet on their trip to map the Mississippi River in 1653. French Jesuit explorer Louis Hennepin made a campsite on the Cairo peninsula in 1660, and the first fort and tannery were built in 1702 by Pierre Charles Juchereau de St. Denys. By 1703, Native Americans had driven off the French, destroyed the village, and effectively curtailed European settlement for over 110 years (Weiser 2012).

On November 16, 1803, Meriwether Lewis, William Clark, and the Corps of Discovery Expedition "… landed on the point at which the Ohio and Mississippi form there [*sic*] junction…" (now Cairo, Alexander County, Illinois). The exploration party remained until November 21, 1803, to conduct scientific research before continuing up the Mississippi on their historic westward journey (Lewis et al. 2005). In 1818, John Comegys obtained a charter to establish a city on the peninsula by the convergence of the two rivers, but his plans never materialized due to lack of financial support. Nevertheless, Comegys coined "Cairo" as the name for the future city from his deduction that the Ohio River delta resembled the delta of the Nile River in Cairo, Egypt. Thereafter, "Cairo" and the "Little Egypt" area became standard usage throughout southern Illinois (Bradsby 1883; Lansden 1910; Lantz 1972). Cairo was founded in 1837 by the Cairo City and Canal Company, incorporated into a city in March 1858, and designated the county seat of Alexander County in 1860 (Bradsby 1883; Lansden 1910; Lantz 1972).

The 19th century history of Cairo has been well recorded including accounts of its pioneer settlements, major shipping port, building of factories, warehouses, levees, and canals, completion of the Illinois Central Railroad in 1854, occupation by the Union Army and Navy in April 1861 during the Civil War, decline of steamboat river commerce, and the severe effects of great floods (Bradsby 1883; Lansden 1910; Lantz 1972; Beadles 1990). Other past occurrences, such as the turbulent events of the 1967–1973 Civil Rights Movement, general decay of the city, and demographic changes in the mid-20th century, have also been reported (Lantz 1972; Ewing & Roddy 1996; Weiser 2012). According to the 2010 United States Census, the population of Cairo was 2381 individuals (Illinois Demographics 2013). Weiser (2012) described Cairo, Illinois, as a "ghost town," a historical city that left behind evidence of its previous glory.

Historical Mistletoe Literature Near Cairo

White (1997) presented significant references on the flora and vegetation of the nearby Cache River, and some reports directly pertained to American mistletoe along the Ohio River near or at the junction with the Mississippi River in Alexander County, Illinois.

The Journals of the Lewis and Clark Expedition (1803–1806) originally written by Meriwether Lewis were edited by G.E. Moulton two centuries later at the University of Nebraska (Lewis et al. 2005). These documents provide a unique introduction into the past vegetation of this area. Lewis et al. (2005) noted the abundance of large silver maple (*Acer saccharinum* L.), American elm (*Ulmus americana* L.), eastern cottonwood (*Populus deltoides* W. Bartram ex Marshall), and American sycamore (*Platanus occidentalis* L.) floodplain forests, and river cane [*Arundinaria gigantea* (Walter) Muhl.] thickets along the Ohio and Mississippi shorelines. On November 21, 1803, while moored near the confluence of the Ohio and Mississippi Rivers, Lewis et al. (2005) recorded:

…"from this place, I observed a large quantity of Misseltoe [*sic*] on the trees bordering on the river, on the main shore… in descending the Ohio, I furst [*sic*] observed this plant about the mouth of the Muskingum river [joins Ohio River, near Marietta]…it [mistletoe] continued increasing until I arrived at the mouth of the Ohio [junction of the Ohio and Mississippi, Alexander County, Illinois] and still continues in larger quantities on this [Mississippi] river than on the Ohio, in so much that the trees at this place were perfectly loaded with it."

On his trip down the Ohio River to the confluence of the Mississippi, Judge James Hall (1838) recorded in his *Notes on the Western States*:

"The mistletoe is seen hanging from the branches of the trees throughout the whole course of the Ohio. It becomes more abundant after passing Cincinnati, and is seen in the greatest profusion between Louisville and the mouth of the river [at Cairo]. This little plant never grows upon the ground, but with a very poetic taste, takes up its attic residence upon the limbs of the tallest trees. The berry which contains the seed, is so viscous as to adhere to the feet of birds, which carry it from tree to tree, and thus contribute to the propagation of this ornamental parasite."

In a letter to his northern Illinoisan friend J. Danforth, in December 24, 1861, Captain George Dodge (1861) at Camp McClernand wrote on the presence of mistletoe and the living conditions at Cairo:

"We are located about one and a half miles north of this city [Cairo], and almost on the only ground that I have seen which is susceptible of being drained. Standing here and there, thro' our camp is a number of stately sycamore trees, upon whose boughs hang pendant tufts of mistletoe, and which would, in almost any other place look very pretty, but here in this low, flat, muddy sink and hot-bed of diarrheas, ague, and fevers, although a rare thing to us of the north, [mistletoe] is hardly even looked at, and seldom mentioned."

Mistletoe was even commemorated during the Civil War, when a small steamboat tug, built in 1861 under the name *Restless* at St. Louis, was purchased by the Union Army early in the Civil War for service in the Western Naval Flotilla. In 1862, the tugboat was renamed, *USS Mistletoe*, after the "parasitic green shrub" (Mooney 1968). The tugboat then was transferred to the Navy at Cairo, Illinois, where it joined the Mississippi River Squadron toward the 1863 assault upon Vicksburg. After the Civil War in 1864, *USS Mistletoe* was decommissioned and sold at public auction in Mounds City, Illinois. It was renamed *Ella Wood* in 1866 and remained in merchant service until 1871 (Mooney 1968).

Cairo Location and Description

The land area inside the Cairo Corporate Boundary encompasses 1750 ha, and consists of Fort Defiance Park (22 ha), Angelo Towhead (311 ha), agricultural bottomland and floodplain forest (661 ha) southwest of Cairo, the Future City (40 ha), the Cairo Regional Airport (190 ha), and the incorporated city (526 ha) of Cairo (Soil Survey Staff 2013; Fig. 1). The study area for this mistletoe survey was restricted to the incorporated Cairo city limits situated within the Cairo Quadrangle (Fig. 1). The southern boundary lies just south of the Cairo Sewage Disposal Plant and Levee Road between latitude 36°59'38.976"N and longitude 89°9'15.768"W (at 95 m asl), and the northernmost border of the Illinois Central Railroad overpass levee (The Cairo Gate) is located at latitude 37°1'14.998"N and longitude 89°11'17.998"W (96 m asl). The eastern boundary is created by the concrete floodwall adjacent to the Ohio River (100 m asl), while the western boundary is determined by the top of the long earthen Levee Road (105 m asl) of the Mississippi River. The eastern and western levees then adjoin the northern levee of the 1903 Illinois Central Railroad bridge (Fig. 1).

Cairo is broadly bisected into western and eastern portions by US 51N to Washington Avenue then north-northeast on Sycamore Street towards Mounds, Illinois (Fig. 1). The major Cairo population resides in older neighborhoods primarily in the western section beyond Washington Street and Sycamore Street. The eastern half of the city is comprised of many fewer residences, a soybean oilseed processing company, the Bunge Cor-

poration of North America, and numerous abandoned, decaying commercial buildings, vacant lots, houses, and rubble among the dilapidated "Historic Downtown Cairo" district. However, Cairo has some fine examples of historic architecture listed in the National Register of Historic Places; e.g., Riverlore Mansion (1865), Magnolia Manor (1872), the U.S. Custom House Museum (1872), A.B. Safford Memorial Library (1883), at least nine stone churches dating from 1857 to 1964, and the American sculptor, George Grey Barnard's The Hewer (1906) bronze statue (Pilotlight 2005).

Physiography and Geology

Fenneman (1938) mapped extreme southern Illinois within the Southeastern Lowlands of the Mississippi Alluvial Plain of the Gulf Coastal Plain Province. Keys et al. (1995) classified extreme southern Illinois into the North Mississippi River Alluvial Plain Subsection, Mississippi Alluvial Basin Section of the Eastern Broadleaf Forest. Omernik (2007) mapped the southern Illinois area of Alexander County into the Mississippi Alluvial Plain. The Cairo Peninsula lies entirely within the Bottomlands Section of the northern extension of the unglaciated Gulf Coastal Plain Province (Leighton et al. 1993). Specifically, Cairo is situated within the Bottomland Section of the Gulf Coastal Plain Division of Alexander County (Schwegman et al. 1973; White 1997). Although the Bottomland Section of the Coastal Plain Division was not glaciated, the overall effects of outwash and alluvial deposits have largely determined the present physiography, soil development, and vegetation.

Nelson (2008) described the geology of Cairo and environs in detail from the Cairo Quadrangle. The geology of the Cairo Peninsula belongs to the Cahokia Formation with clayey deposits ranging from 8 to 52 m deep from the Holocene Stage of the Quaternary System. The superficial sediments from 5 to 10 m in depth consist of mottled medium to dark gray clay, silty clay, and silt containing very fine to fine sands with quartz and chert among organic matter (Nelson 2008).

Soils

The topography of incorporated Cairo is nearly level (<1.0–2.0% slope) with an elevation gradient of 94 to 97 m asl from southern to northern boundaries. Much of the soil in Cairo has initially been excavated and redeposited during construction to level roads, streets, and railways, levees, homes, and business enterprises due to its location on the great floodplain of the Mississippi and Ohio Rivers. The soil data are derived from Williams et al. (2007) and Soil Survey Staff (2013). The soils of Cairo (526 ha) are comprised mainly of one artificial earthy fill soil and seven major alluvial soil series on the broad floodplain bottomlands prior to enclosing the corporate city area within levees and flood walls.

Orthents (215 ha/40.9 % of Cairo area) are excavated, earthy fill materials that had been redeposited over the generally level Cairo floodplain and in construction of levees. Orthents are undulating to hilly 15–200 cm deep silty loams, moderately well drained, and strongly acidic in reaction (Williams et al. 2007; Soil Survey Staff 2013). The seven naturally deposited soils are Beaucoup (28 ha/5.4%), Cairo (27 ha/5.2%), Darwin (51 ha/9.6%), Gorham (49 ha/9.2%), Riley (37 ha/7.2%), Tice (89 ha/16.9%), and Ware (30 ha/5.6%). The seven alluvial silty clay to silty clay loam soils are very poorly drained to poorly drained to rarely moderately well-drained with very slow to slow permeability, and strongly acidic to moderately acidic to near neutral in reaction. The depth of these soils varies from 50 to 203 cm. Under natural seasonal bottomland flooding conditions, these alluvial soils are annually flooded and are deposited on existing sediments by the Mississippi and Ohio Rivers outside of the Cairo boundary (Parks & Fehrenbacker 1968).

Climate

The climate of Cairo is of the humid subtropical (Köppen Cfa) type (Rosenberg 2013). Precipitation at this mild mid-latitude tends to be spread relatively evenly throughout the year without a significant dry season. Summers are hot and humid with temperatures frequently nearing 32.2°C. The low elevation and proximity to the Mississippi and Ohio Rivers hold in the summer heat and the high humidity creates hot, muggy conditions. Winters are generally cool with mild periods due to the elevations and proximity to the rivers preventing strong winter lows and plunging temperatures. Winter climate is the major limiting factor to mistletoe distribution along the Ohio River in southern Illinois, Indiana, and Ohio, and the Mississippi River in southeastern Missouri and southern Illinois.

The Cairo area has the mildest climate in Illinois. Climate data for 1971–2000 are from Cairo 3 N Station 111166 (Midwest Regional Climate Center 2013). Mean annual temperature in Cairo is 14.7°C with the coldest month in January (0.7°C) and the warmest month in July (26.9°C). Mean annual precipitation is 121.5 cm and a mean snowfall of 24.4 cm. The least rainfall occurs in September (7.7 cm) and the most rainfall in April and May (each 12.1 cm). The longest growing season is 270 days, based on 0°C, and the median growing season is 228 days. The last freeze approximates April 9 and the first frost occurs around October 22.

Vegetation and Plant Communities

Braun (1950) classified the forest region at the northern extension of the Mississippi Gulf Coastal Plain in southern Illinois as Southeastern Evergreen Forest of Bottomland Hardwood Forest composition, while Küchler (1964) placed vegetation of the region in the Southern Floodplain Forest. Dyer (2006) in a reclassification of Braun's forest regions, subsequently mapped her Southeastern Evergreen Forest of the Mississippi Gulf Coastal Plain as the Mississippi Alluvial Plain Mesophytic Forest. Voigt and Mohlenbrock (1964) classified the lowland plant communities as Bottomland Forest in Alexander, Pulaski, Massac, and Pope Counties of southern Illinois. They recognized five floodplain types of vegetation-moisture classes in the adjacent Lower Wabash Valley that ranged from heavy-wet (littoral), wet (overflow bottom), wet-moist (overflow terrace), very moist (aggraded terrace), to moist floodplain. In the Bottomland Section of southern Alexander County, bottomland forests are mainly mesic floodplain, wet-mesic floodplain, and wet floodplain forest based on natural physical features (topographic elevation and aspect, soil moisture, reaction, and permeability, frequency and duration of flooding, geological substrate and glacial history), and species composition of woody flora and existing vegetation (White & Madany 1978; Taft & Mankowski 1997). The characteristic forest communities of the Bottomland Section at Horseshoe Lake Conservation Area in Alexander County, 27 km northwest of Cairo at 98 m elevation asl, are characterized as swamps, wetland marsh, wet floodplain, and wet-mesic floodplain forest (Basinger et al. 1997). Hosner and Minckler (1963) described tree species composition in a successional study of bottomland hardwood forest in southern Illinois, which included three Alexander County sites, as representative of a mixed soft-hardwoods forest.

Near Cairo and environs, lands disturbed by annual flooding and siltation are composed of wet floodplain forest, while seasonally flooded terraces are primarily wet-mesic floodplain forest. Species composition of wet floodplain forest along the Ohio and Mississippi Rivers is comprised of riparian trees, most of which also inhabit wet-mesic floodplain forest. Wet floodplain indicator trees are American sycamore, black willow (*Salix nigra* Marshall), box elder (*Acer negundo* L.), eastern cottonwood, river birch (*Betula nigra* L.), and sandbar willow (*Salix exigua* Nuttall). Characteristic hardwoods of wet-mesic forests include American elm, green ash (*Fraxinus pennsylvanica* Marshall), hackberry (*Celtis occidentalis* L.), honey locust (*Gleditsia triacanthos* L.), pin oak (*Quercus palustris* Muenchh.), red elm (*Ulmus rubra* Muhl.), sweetgum (*Liquidambar styraciflua* L.), and sugarberry (*Celtis laevigata* Willd.). These taxa are all present inside the levees of Cairo. Woody species richness and species diversity become higher in bottomlands as the moisture gradient progresses from wet floodplain to wet-mesic floodplain to mesic floodplain forest.

Nevertheless, the predominate plant community within the incorporated boundaries of Cairo consists of woody vegetation including natural remnants and cultivated taxa interspersed among the open graminoid Culturally Derived Community. This major community has been maintained throughout the past to present by anthropogenic disturbances (e.g., lawns, yards, streets borders and medians, parks, vacant lots, woodlots, and numerous other ruderal disturbed habitats).

The woody plant species growing and populating the Culturally Derived Community are mainly native species characteristic of wet floodplain and wet-mesic floodplain forests. Mesic floodplain forest of drier habitats includes those trees of wet and wet-mesic forest with the addition of black cherry (*Prunus serotina* Ehrh.), black walnut (*Juglans nigra* L.), pecan [*Carya illinoensis* (Wang.) K. Koch], red maple (*Acer rubrum* L.), and sugar maple (*A. saccharum* Marshall), among other species. Trees differ significantly in species composition in the open habitats through selective planting of ornamental native and exotic trees. Some natural wet-mesic floodplain woodlots and groves are established in Cairo through volunteering of natives and naturalization

of some exotic trees, e.g., Callery pear (*Pyrus calleryana* Decne.), paper mulberry [*Broussonetia papyrifera* (L.) L'Hér. ex Vent.], and tree-of-heaven [*Ailanthus altissima* (P. Mill.) Swingle]. The more abundant mistletoe-infested trees of floodplain habitats in the Culturally Derived Community tended to be characteristically mature, taller, open-canopied, and located in insolated areas.

METHODS AND MATERIALS

An intensive American mistletoe field survey was conducted within the incorporated city limits of Cairo during March–December 2011, June 2012, and March–April 2013. A vehicle odometer was utilized to record mileage traveled on all paved streets and unpaved gravel roads. Other terrain was traversed through walking reconnaissance. Cairo street maps from City Hall and enhanced Cairo topographic maps (Google Earth 2013) were extensively utilized as street, terrain, and GPS guides.

Nikon Monarch 5 ATB™ 8 × 42 binoculars were used to identify each specific host tree with visible aerial signs of mistletoe infestation or malformation (i.e., sprigs, clumps, clusters, cankerous swellings, leafless brooms, limb dieback). Each host was recorded by tree species, degree of mistletoe infestation, and precise Cairo location. Mohlenbrock (2002) was followed for native tree nomenclature, and USDA, NRCS (2013) was used for selected non-native trees.

The Mistletoe Infestation Index (MIS), a scale of infestation categories (Thompson et al. 2008), was followed and an inclusive index was given for host tree species: light infestation (1–10 clusters), moderate infestation (11–30), heavy infestation (31–100), and extensive infestation (101+). Hemmerly (1989) was used to derive a Mistletoe Occurrence Value (MOV), a spatial distribution pattern and relative abundance value of host trees per kilometer. This density factor is calculated by the total number of host trees divided by the total number of kilometers travelled.

Documentation of selected host trees was by collecting representative voucher specimens with a 12 m extendible fiberglass linesman pole. Each mistletoe voucher specimen was collected with a winter twig or leafy branchlet to substantiate the host tree species. Vouchers were mounted, labeled, and deposited in the Berea College Herbarium (BEREA). A duplicate set of representative mistletoe specimens will be distributed to ILLS (Appendix 1, 2), and other selected duplicate specimens will be sent to BRIT, EIU, MO, MU, and NCU. Acronyms for all herbaria follow Thiers (2014).

In 2012, to document Illinois distribution data of *Phoradendron leucarpum* ssp. *leucarpum*, all available Illinois mistletoe herbarium specimens were annotated from BEREA, EIU, F, ILL, ILLS, IND, ISM, KY, MO, MU, NCU, NY, OSU, and SIU. Descriptive data gathered from each American mistletoe specimen were Illinois county, location, habitat, host tree identification (when listed), collector(s), collector number [or *sino numero* (*s.n.*)], collection date, and herbarium depository.

During March 30–31 and April 1–2, 2013, a extensive mistletoe reconnaissance was made from 14 southern Illinois counties. The field search for mistletoe trees was focused in towns and cities and along terrain bordered by major rivers. In previous Kentucky mistletoe surveys [e.g., Thompson & Noe (2003), Thompson & Poindexter (2005), Thompson et al. (2008), Thompson & Evans (2010)], a high number of host trees were typically associated with urban areas. Wooded terrain along Illinois rivers and streams tend to provide more protected microclimates. Mohlenbrock (1990) reported American mistletoe as occasional from low woods in the southern 19 Illinois counties (Fig. 3). He noted 15 counties were contiguous to the river borders of the Mississippi, Ohio, Wabash, Cache, Saline, and other southern Illinois river tributaries.

The 2013 reconnaissance of 14 counties included the Mississippi River counties (Alexander, Union, Jackson, Randolph) eastward to Williamson and Saline counties, the Wabash River counties (Wabash, White, Gallatin), down the Ohio River counties (Gallatin, Hardin, Pope, Massac, Pulaski, Alexander), and the Cache River counties (Johnson, Pulaski, Alexander). This collecting trip covered portions of the Coastal Plain Province, Salem Plateau Section (Ozark Plateau Province), Mt. Vernon Hill Country, the Till Plains Section (Central Lowland Province), and Shawnee Hills Section (Interior Low Plateau Province) as delineated from the Illinois physiographic provinces map of Leighton et al. (1993).

Fig. 3. Nineteen Southern Illinois counties ranked by total identified mistletoe host tree species plus unidentified hosts (Note: Table 2): **1)** Alexander, **2)** Pulaski, **3)** Hardin,**4)** Union, **5)** Massac, **6)** Pope, **7)** Jackson, **8)** Johnson, **9)** Gallatin, **10)** Randolph, **11)** Wayne,**12)** Wabash, **13)** St. Clair, **14)** Crawford, **15)** Williamson, **16)** Saline, **17)** White, **18)** Lawrence, **19)** Clark.

RESULTS AND DISCUSSION

Mistletoe Survey in the city of Cairo, Alexander County

Phoradendron leucarpum ssp. *leucarpum* was recorded in 547 hosts among 13 tree species (9 native, 4 introduced exotics) within Cairo (Table 1). Predominate mistletoe-infested tree species were silver maple (304 trees) followed by American elm (111 trees). Other significant host trees in order of abundance were sugarberry (29), red maple (22), paper mulberry (17), Callery pear and green ash (16 each), sugar maple (14), and black walnut with 13 (Table 1).

From this Cairo inventory, nine host trees were documented for the first time in Illinois and are indicated by an asterisk (*). Five of these new host trees, green ash, red maple, river birch, sugarberry, and sugar maple, are native volunteers and/or planted. The remaining four hosts, Bradford pear, Himalayan white birch [*Betula utilis* D. Don. ssp. *jacquemontii* (Spach.) Winkl.], Japanese pagoda tree [*Styphnolobium japonicum* (L.) Schott], and paper mulberry, are planted and/or escaped exotics. Himalayan white birch and Japanese pagoda tree with a double asterisk (**), are new host tree records for North America (Table 1).

Seven of the eight host trees listed by Overlease and Overlease (2005) were documented in the Cairo survey (Table 1): American elm, black walnut, red maple, river birch, silver maple, sugarberry, and sugar maple. Although not found in Cairo specifically, the remaining taxon, white ash, listed by Overlease and Overlease (2005), was later documented in two counties. Silver maple and American elm were the highest two documented hosts in the Cairo study as recorded in the Illinois survey by Overlease and Overlease (2005).

Mistletoe occurrence often varied from one to over 100 clusters among hosts of the same species, and the MIS was highly correlated with number of overall host trees (Table 1). The host trees with MIS of only light infestation (1–10 clusters) were honey locust, Himalayan white birch, Japanese pagoda tree, and river birch. Host trees with moderate infestation (11–30 clusters) were black walnut, green ash, paper mulberry, red maple, and sugarberry. Host trees with heavy infestation (31–100 clusters) included American elm and silver maple, and a few older American elm and silver maple had extensive infestation (101+), which could lead to host mortality.

The majority of mistletoe-infested host trees were found in the Culturally Derived Community occupying older populated areas interspersed among open street shoulder margins, paved and unpaved gravel roadsides and medians, yards, city park lawns, church and school yards, and vacant city lots in Cairo proper. The 6.2 ha lawn of St. Mary's Park, established in 1872, had nine native or exotic planted tree species infested with mistletoe. Some host trees were present in wet floodplain forest along the shoreline and levees of the Mississippi and Ohio Rivers. Several other hosts inhabited small open-canopied groves or woodlot remnants of wet-mesic floodplain and mesic floodplain forests throughout non-residential areas within Cairo. More concisely, Cairo lacks any significant natural vegetated areas. Rather, the city is mainly comprised of land subjected to long-term anthropogenic disturbance or altered by bottomland flooding regimes.

As expected, few host trees with mistletoe were observed in the environs outside of the incorporated Cairo city limits. The most common mistletoe-infested host trees were typically also the most numerous canopy trees (i.e., silver maple and American elm). Those host trees in close proximity to each other generally appeared to facilitate greater mistletoe seed dispersal, which likely contributed to the increased aggregated (clumped) mistletoe distribution pattern observed within Cairo. Older and taller mature host trees characteristically formed open canopy crowns with better insolation for mistletoe success and provided greater infestation opportunities from avian vectors over time.

The Mistletoe Occurrence Value (MOV) from 547 mistletoe-infested trees per 40.8 km (25.2 mi) of roads was 13.41 in Cairo. This high density value is a result of the city focus, whereas countywide surveys include much larger expanses of non-urbanized land; e.g., Thompson and Noe (2003) recorded 3502 host trees from 15 tree species in traversing 805 km for a MOV of 4.35 host trees/km in Rockcastle County, and in Garrard County, Thompson and Poindexter (2005) documented 1740 host trees from 12 tree species in traveling 523 km for a MOV of 3.33 host trees/km.

Fifty-two specimens (26 vouchers and 26 duplicates) collected in the Cairo survey are presented with complete label information (Appendix 1). The determination of Illinois state host tree records from Cairo was based on the initial herbarium searches. Six incidental mistletoe specimens (American elm, an oak, black gum (*Nyssa sylvatica* Marshall), silver maple, and two unidentified tree hosts) from other herbaria were examined from Alexander County (Appendix 2). The additions of American elm, black gum, and silver maple specimens added to the nine new tree species of the Cairo study (Table 1) accounted for 14 host trees among the 21 overall hosts for Illinois (Table 2).

Previous Relevant Illinois Mistletoe Collections and Surveys

Schneck (1884a) collected seven *Ulmus americana* specimens in different phenological stages and wrote his

Table 1. Host specificity of *Phoradendron leucarpum* within city limits of Cairo, Illinois.

Host Tree Species	No. Trees	Percent
Acer saccharinum L.	304	55.58
Ulmus americana L.	111	20.29
**Celtis laevigata* Willd.	29	5.30
**Acer rubrum* L.	22	4.02
**Broussonetia papyrifera* (L.) L'Hér. ex Vent.	17	3.11
**Fraxinus pennsylvanica* Marshall	16	2.93
**Pyrus calleryana* Decne.	16	2.93
**Acer saccharum* Marshall	14	2.56
Juglans nigra L.	13	2.38
**Betula nigra* L.	2	0.36
Gleditsia triacanthos L.	1	0.18
***Betula utilis* D. Don ssp. *jacquemontii* (Spach) Winkl.	1	0.18
***Styphnolobium japonicum* (L.) Schott	1	0.18
Total Species: 13	547	100.00

(*) New Illinois host trees vouchered for American mistletoe.
(**) New United States host species vouchered for American mistletoe.

Table 2. Nineteen southern Illinois counties ranked according to identified mistletoe host tree species plus unknown hosts, collectors, specimens, and year(s) of collection from 225 herbarium specimens (Note: Fig. 3, Appendix 1, 2).

County	Host Species + Unknowns	Collectors	Number of Specimens	Collection Years
1 Alexander	14 + 3	7	65	1939, 1947, 1970, 1985, 1992, 2011, 2012, 2013
2 Pulaski	13 + 5	9	36	1860, 1869, 1919, 1939, 1949, 1950, 1985, 1989, 2013
3 Hardin	7 + 1	4	19	1947, 1949, 2013
4 Union	6	4	14	1948, 1949, 1955, 2013
5 Massac	4	4	12	1902, 1948, 1949, 2013
6 Pope	4	4	8	1931, 1948, 1949, 2013
7 Jackson	3 + 1	5	12	1948, 1949, 1956, 1985, 2013
8 Johnson	3 + 1	4	9	1948, 1949, 1989, 2013
9 Gallatin	3	4	6	1948, 1949, 2013
10 Randolph	2 + 2	5	8	1949, 1955, 1961, 1977, 2013
11 Wayne	2	2	3	1949, 1958
12 Wabash	1 + 1	5	12	1882, 1883, 1912, 1949, 2013
13 St. Clair	1 + 1	2	2	1861, 1955
14 Crawford	1	3	5	1949, 1973
15 Williamson	1	3	3	1949
16 Saline	1	3	3	1949
17 White	1	3	3	1949
18 Lawrence	1	3	4	1949
19 Clark	1	1	1	1949

T = 225 specimens

descriptive notes on each label, which was a source for his article describing the life cycle of mistletoe. Schneck (1884b) observed mistletoe on 28 honey locust trees, a pin oak, one red elm, 11 silver maples, and "*Ulmus americana*, many thousand" over an 18 month period in 1882–1883 at Mt. Carmel, Illinois, in Wabash County. Trelease (1916) excluded Champaign County, *J. Perriam s.n.* (ILL), no date, as "doubtless error of locality" and no other Champaign County specimens were found. Thompson and Bennett (1938) reported [American] elm and [silver] maple as the major trees infested by mistletoe at Horseshoe Lake in Alexander County near Cairo. Tehon (1942) discovered that mistletoe prefers American elm and black gum in southern Illinois along the Ohio and Wabash River bottomlands northward to Wabash County, and the Mississippi River bottomlands

north to Union County. Jones (1945) reported mistletoe as parasitic on American elm, black gum, oak, and other deciduous trees in southern Illinois northward to Union and Lawrence counties. Jones (1963) later added Randolph, Saline, and Crawford counties as containing mistletoe. Carter (1964) listed mistletoe occurrence in 18 Illinois counties and hosts as mainly [American] elm and occasionally black gum, black walnut, honey locust, oak, [silver] maple, and sycamore. Mohlenbrock (1990) listed American elm and sweetgum as host trees. American elm was the predominant host named on herbarium specimens; sweetgum was not verified as a host tree by any representative vouchers from either the herbaria search or this study.

Overlease and Overlease (2005) conducted a reconnaissance survey of American mistletoe (under synonym, *Phoradendron serotinum* (Raf.) M.C. Johnston), with a focus on the distribution, host species, and abundance across its geographical range in the eastern United States. Although they did not collect herbarium vouchers, their identification of host trees in Illinois is accepted from their extensive study. Overlease and Overlease (2005) listed eight host trees for Illinois with the two major hosts in tree numbers and clumps of mistletoe as silver maple (93 trees/2334 mistletoe clusters) and American elm (39 trees/3339 mistletoe clusters). The remaining host trees listed were sugar maple (9/343), red maple (7/282), sugarberry (4/58), black walnut (4/47), white ash [*Fraxinus americana* L. (1/6)], and river birch (1/1). All eight taxa were documented with representative voucher specimens during this study.

Kuijt (2003) cited 23 Illinois voucher specimens (counting six duplicates) from five host trees in 14 Illinois counties from A, GH, ILL, K, MO, NY, US, and WIS. Host trees were a black gum, a black locust (*Robinia pseudoacacia* L.), an oak, a winged elm (*Ulmus alata* Muhl.), 13 American elms, and three unidentified trees. Eighteen vouchers cited by Kuijt (2003), which represented all 14 counties from ILL, MO, and NY, were examined in this study. These 18 specimens are denoted by a dagger (†) in Appendix 2.

All 19 Illinois counties mapped for American mistletoe by Mohlenbrock (1990) were documented in the herbarium searches. Ninety-seven voucher specimens were annotated from holdings at EIU (4), F (0), ILL (33), ILLS (31), IND (0), ISM (16), KY (0), MO (2), MU (1), NCU (2), NY (3), OSU (0), and SIU (5). Twenty-six collection years of these voucher specimens ranged from 1860 to 1992 (Table 3). These 97 specimens (84 vouchers and 13 duplicates) are comprised of 77 identified hosts (10 duplicates) from eight host tree species, and 20 unidentified hosts (three duplicates) from 18 specimens without trees listed plus two unknown *Quercus* sp. Mistletoe specimens with documentation of identified host tree on herbarium labels were counted as host tree records. Similarly, specimens with a host tree identified on the labels while listing other mistletoe-infested trees observed, were not counted without an actual mistletoe specimen documented.

The eight identified host tree species by abundance and number of collectors, counties, and herbarium specimens (Appendix 2) are as follows: *Ulmus americana* (12 collectors/16 counties/54 specimens), *Nyssa sylvatica* (9/6/9), *Gleditsia triacanthos* (5/3/6), *Acer saccharinum* (2/2/2), *Platanus occidentalis* (2/1/2), *Robinia pseudoacacia* (2/1/2), *Juglans nigra* (1/1/1), *Ulmus alata* (1/1/1), and no host identified including the two *Quercus* sp. (10/9/20). In the Illinois herbaria search, the major host by far was American elm followed distantly by black gum. These data were reported in previous botanical literature (Tehon 1942; Jones 1945, 1963; Jones & Fuller 1955; Carter 1964).

A summary of the 97 voucher specimens is listed by decade followed by the 26 collectors, number of their specimens, and collection year (Table 3). Fifty-five of the 97 specimens (56.70%) within 18/19 counties were collected by three taxonomists, H.E. Ahles (7 counties/9 specimens), R.A. Evers (16 counties/23 specimens), and G.S. Winterringer (12/23). Several of their representative specimens at ILL, ILLS, and ISM list the same locality information and dates, denoting they often were field collecting companions (Appendix 2). The years, 1948–1949, were clearly the zenith of 20th century Illinois mistletoe collecting (Table 3). It is important to note that 77/97 (79.38%) specimens were collected by 16/26 collectors during 1860–1949, or 154 to 65 years ago (see: Tables 2, 3).

Illinois Mistletoe Documented from 2013 Reconnaissance

The 2013 collecting trip to 14 southern Illinois counties on March 30–31 and April 1–2, 2013, provided 39 more mistletoe herbarium specimens with 37 ILLS duplicates, or 76 herbarium specimens on deposit at

TABLE 3. Summary of 97 Illinois *Phoradendron leucarpum* ssp. *leucarpum* specimens by decade, collector, number of specimens, and year (s).

Decade	Collector	Specimens	Collection Year(s)
1860s	Brendel	1	1860
	Welsch	1	1861
	Raymond	1	1869
1880s	Schneck	7	1882–1883
1900s	Gleason	1	1902
1910s	Trelease	1	1912
	Palmer	1	1919
1930s	Schopf	1	1931
	Boewe	1	1939
	Evers	2	1939
1940s	Bailey	7	1947
	Carter	1	1948
	Evers	18	1948–1949
	Winterringer	23	1948–1949
	Ahles	9	1949
	Sievert	1	1949
	Walker	1	1949
1950s	Evers	1	1950
	Buser	1	1955
	Evers	1	1955
	Neill	1	1955
	Mohlenbrock	1	1956
	Evers	1	1958
1960s	Neill	2	1961
1970s	Furray	1	1970
	Huston	1	1970
	Ebinger	2	1973
	Shildneck	1	1977
1980s	Nickrent	3	1985
	Winslip	3	1989
1990s	Phillippe	1	1992
Totals:	26 Collectors	97 Specimens	24 years represented

BEREA and ILLS (Appendix 2). These 76 Illinois specimens plus the 52 Cairo specimens contributed 128 mistletoe specimens toward this Illinois mistletoe study. Fourteen host tree species were documented during this southern Illinois reconnaissance; eight were also present in the Cairo survey (Table 1). Four new host trees documented for Illinois were *Celtis occidentalis* and *Fraxinus americana* (Hardin and Pulaski counties), and Japanese maple (*Acer palmatum* Thunb.) and *Quercus palustris* (Pulaski County).

Aside from the Cairo survey (Appendix 1), 11 counties provided 76 mistletoe specimens from the 2013 reconnaissance (Appendix 2). County specimen collections were as follows: Alexander (American elm, silver maple), Gallatin (silver maple), Hardin (American elm, black gum, black walnut, hackberry, red maple, sugar maple, white ash), Jackson (black gum, silver maple), Johnson (American elm, silver maple), Massac (red maple [2], silver maple), Pope (black gum, silver maple), Pulaski (American elm, black gum, black locust, green ash, hackberry, honey locust, Japanese maple, pin oak, red maple, silver maple [3], sugarberry, white ash), Randolph (black gum), Union (black gum, red maple, silver maple), and Wabash (American elm). Regardless of extensive searches, mistletoe was not found in Saline, White, and Williamson counties, even though historical collections are known.

Alexander County had the greatest host tree richness with 14 different hosts, Pulaski County provided 13 host tree species with 10 hosts from Mounds City and four from Mounds, and Hardin County accounted for seven host tree species at Cave-in-Rock State Park (Table 2; Appendix 2). Excluding Cairo data (Table 1, Appendix 1), the three leading hosts in the 2013 reconnaissance, were silver maple (8 counties/9 specimens), black gum (6 counties/6 specimens), and American elm (5 counties/5 specimens). Six of the eight host tree spe-

cies previously annotated in the herbarium searches for Illinois specimens (American elm, black gum, black locust, black walnut, honey locust, silver maple) were also collected (Appendix 2). Winged elm and American sycamore were not redocumented as host trees during this study.

The recent observations reveal silver maple to be the most abundant and prevalent mistletoe-infested tree of southern Illinois counties (Table 1; Overlease & Overlease 2005; Appendix 1, 2). This feature is a contrast to the incidence of mistletoe-infested American elm as evidenced from herbarium searches and botanical literature (Appendix 2; Tehon 1942; Jones 1945; Carter 1964; Mohlenbrock 1990). Reasons are not clear for this observation on the abundance of silver maple, although inferences may be made: historical collectors could possibly have ignored or overlooked silver maple as a host tree as only 2/97 were documented with specimens (Appendix 2). American elm certainly was the most collected mistletoe-infested host as evidenced with an occurrence in 16/19 counties and 54 herbarium specimens prior to the 2013 survey. The original Dutch Elm Disease [*Ophiostoma ulmi* (Buism.) Nannf.] and its more aggressive subspecies, the New World Dutch Elm Disease (*Ophiostoma novo-ulmi* Brasier spp. *americana* Brasier & S.A. Kirk) may have taken their toll upon American elms (Brasier & Buck 2001). However, American elm and other host species are not as dominant in 2013 as it was in the 1940s-1960s and latter part of the 20th century. The intensive mistletoe survey of Cairo was the one exception to the occurrence of mistletoe-infested American elm, even then, it was nearly a 3:1 ratio of mistletoe-infested silver maple to American elm with mistletoe (Table 1).

The abundance of American mistletoe in the extreme southern counties and the scarcity as the geographical range progresses upward to the northern and central counties was the paramount observation. Winter climate was clearly the limiting factor in Illinois mistletoe distribution as evidenced by number of collections and specimens through the historic herbarium searches, relevant literature (Schneck 1884a, b; Spooner 1983), and the 2013 county reconnaissance. *Phoradendron leucarpum* ssp. *leucarpum* is near its northernmost distribution in southern Illinois (e.g., its southern extraneous affinity) due to low and prevalent winter temperatures during the past and at the present time. The American mistletoe distribution pattern has remained similar through time: the occurrence of mistletoe-infested host trees *and* number of infested host tree species, continually decreased as counties were inventoried northward along the Mississippi and Ohio Rivers and within the south-central counties both in the past and the present (Table 1, 2, 3; Appendix 1, 2).

Synopsis of Illinois American Mistletoe Study

1) A total of 225 herbarium specimens (97 from herbarium searches, 52 from Cairo, 76 from 2013 county survey) were annotated from 19 southern Illinois counties (Appendix 1, 2); counties ranked by number of host species, collectors, specimens, and years of collection are located in the southernmost Illinois counties (Table 2; Fig. 3).
2) American mistletoe was recorded from 21 different host tree species representative of 11 plant families (Appendix 1, 2); three new exotic host trees for North America documented with *Phoradendron leucarpum* ssp. *leucarpum* are Japanese maple (*Acer palmatum* Thunb.), Himalayan white birch [*Betula utilis* D. Don ssp. *jacquemontii* (Spach) Winkl.], and Japanese pagoda tree [*Styphnolobium japonicum* (L.) Schott].
3) The Cairo survey in Alexander County, documented 26 voucher specimens and 26 duplicates (52 specimens) from 13 hosts with 9 hosts new to Illinois; silver maple and American elm are the two dominant host trees (Table 1; Appendix 1).
4) The herbarium searches for Illinois specimens generated 97 specimens (84 vouchers and 13 duplicates) and provided eight identified host trees for Illinois; American elm and black gum are the two major host trees (Appendix 2).
5) The 2013 reconnaissance survey of 14 southern Illinois counties yielded 39 vouchers and 37 duplicates (76 specimens) within 11 counties from 14 hosts; hackberry, pin oak, white ash, and Japanese maple are four new Illinois hosts, and silver maple, black gum, and American elm are the three leading host trees by county (Appendix 2).
6) American mistletoe was much more abundant and with greater host tree diversity near cities; e.g., Cairo, Metropolis, Mounds, Mounds City, and the major rivers in the extreme eastern (Wabash), southern (Cache,

Ohio, Saline), and western (Mississippi) counties; mistletoe is very scarce in the northern and central counties as evidenced in this study and the herbarium searches (Fig. 3; Table 2; Appendix 1, 2).

CONCLUSIONS

Cairo has the highest incidence of American mistletoe [*Phoradendron leucarpum* (Raf.) Rev. & M.C. Johnston ssp. *leucarpum*] and the greatest number of host species for any town or city in Illinois. In Cairo, the Mistletoe Occurrence Value (MOV) was 13.41 trees/km from 547 mistletoe-infested trees per 40.8 km of roads travelled.

The major parameter for mistletoe occurrence and distributional spread in southern Illinois is largely related to climatic conditions (e.g., a continued mild winter climate and buffering effects by major rivers along open lowland topography). Other important factors for the incidence of mistletoe include the availability of mature, open-canopied host trees, culturally derived habitats of towns and cities, and influence of the Mississippi Flyway corridor for bird dispersal of fruits and seeds. The rather mild winter temperatures for the last several years within the USDA Plant Hardiness 6b Zone has been conducive for evergreen mistletoe establishment, growth, proliferation, and migration in southern Illinois. The incidence of mistletoe in different hosts species and in quantities correlates with its southern extraneous geographical affinity. Further American mistletoe surveys, preferably with winter twigs or branchlets added to mistletoe vouchers specimens, would enhance host tree identification and overall host species toward mistletoe distribution in southern Illinois counties.

APPENDIX 1

ANNOTATED CAIRO MISTLETOE COLLECTIONS

ILLINOIS. Alexander Co.: Cairo: Cedar St. sidewalk jct. Cross St. adj. to abandoned Southern Medical Center Hospital, 37°00′9.50″N, 89°10′44.61″W, elev. 97 m, hemiparasitic on *Acer saccharinum*, 2 Mar 2011, *R.L. Thompson 11-02* (BEREA, ILLS); 25th St. & Sycamore St. in yard behind Spirit's House Liquor, 37°00′32.49″N, 89°10′30.76″W, elev. 94 m, on *Juglans nigra*, 2 Mar 2011, *R.L. Thompson 11-05* (BEREA, ILLS); 7th St. & Washington Ave. median, 36°59′59.09″N, 89°9′58.43″W, elev. 96 m, moderately-infested *Acer saccharinum*, 2 Mar 2011, *R.L. Thompson 11-07* (BEREA, ILLS); DayStar Care Center, 2001 Cedar St. at end of Cross St., 37°00′39.52″N, 89°10′44.25″W, elev. 95 m, on introduced *Pyrus calleryana*, 2 Mar 2011, *R.L. Thompson 11-08* (BEREA, ILLS); St. Mary's Park, founded 1872, lawn bordering Magnolia Drive, 37°00′38.18″N, 89°11′8.49″W, elev. 95 m, on *Acer rubrum*, 8 Mar 2011, *R.L. Thompson & R.J. Trites 11-14* (BEREA, ILLS); St. Mary's Park lawn near park pavilion, 37°00′36.57″N, 89°11′9.24″W, elev. 95 m, on *Betula nigra*, 8 Mar 2011, *R.L. Thompson & R.J. Trites 11-15* (BEREA, ILLS); 36th St. & Washington Ave. median, 36°59′59.09″N, 89°9′58.43″W, elev. 96 m, on *Acer saccharum*, 8 Mar 2011, *R.L. Thompson & R.J. Trites 11-21* (BEREA, ILLS); 19th St. jct. with Washington Ave. (US 51N) in yard behind Dairy Hut and Dairy Mart, 1808 Washington Ave., 37°00′16.77″N, 89°10′29.33″W, elev. 96 m, heavily-infested on *Ulmus americana*, 8 Mar 2011, *R.L. Thompson & R.J. Trites 11-24* (BEREA, ILLS); St. Mary's Park lawn, 37°00′35.15″N, 89°11′9.09″W, elev. 96 m, on lightly-infested ornamental *Styphnolobium japonicum*, 22 Apr 2011, *R.L. Thompson & R.J. Trites 11-69* (BEREA, ILLS); St. Mary's Park lawn adj. to Magnolia Drive, 37°00′37.18″N, 89°11′8.14″W, elev. 95 m, on *Celtis laevigata*, 22 Apr 2011, *R.L. Thompson & R.J. Trites 11-70* (BEREA, ILLS); St. Mary's Park lawn adj. Park Place, 37°00′31.69″N, 89°11′10.54″W, elev. 96 m, lightly-infested *Gleditsia triacanthos*, 22 Apr 2011, *R.L. Thompson & R.J. Trites 11-71* (BEREA, ILLS); 418 Cross St. and M.L. King Ave., 37°00′13.77″N, 89°10′41.47″W, elev. 95 m, on three infested *Fraxinus pennsylvanica*, 5 Jul 2011, *R.L. Thompson 11-447* (BEREA, ILLS); St. Mary's Park lawn, 37°00′35.15″N, 89°11′9.09″W, elev. 96 m, on exotic *Styphnolobium japonicum* with three clumps, 5 Jul 2011, *R.L. Thompson 11-448* (BEREA, ILLS); St. Mary's Park lawn across from 2817 Park Place, 37°00′31.69″N, 89°11′10.54″W, elev. 96 m, three clusters on planted *Gleditsia triacanthos*, 13 Aug 2011, *R.L. Thompson 11-550* (BEREA, ILLS); St. Mary's Park yard near pavilion, 37°00′35.21″N, 89°11′9.00″W, elev. 95 m, on *Acer saccharum*, 13 Aug 2011, *R.L. Thompson 11-551* (BEREA, ILLS); back yard behind 3111 Washington Ave. residence adjacent to Magnolia Ave., 37°00′38.75″N, 89°11′6.90″W, 96 m elev., on *Betula nigra*, 13 August 2011, *R.L. Thompson 11-556* (BEREA, ILLS); Cairo High School, 37°1′11.25″N, 89°11′15.41″W, elev. 96 m, on *Acer rubrum*, 13 Aug 2011, *R.L. Thompson 11-564* (BEREA, ILLS); Cairo High School, moderately-infested ornamental *Pyrus calleryana* at front entrance, 37°1′9.57″N, 89°11′14.43″W, elev. 96 m, 13 Aug 2011, *R.L. Thompson 11-565* (BEREA, ILLS); 25th St. & 2501 Holbrook Ave., 37°00′9.33″N, 89°10′45.36″W, elev. 95 m, a single clump on mature *Fraxinus pennsylvanica*, 13 Aug 2011, *R.L. Thompson 11-566* (BEREA, ILLS); 229 12th St. E of Poplar St., yard of Ronnie Garrett, 37°00′7.82″N, 89°10′9.95″W, elev. 95 m, on introduced ornamental *Betula utilis* ssp. *jacquemontii* with four clusters, 11 Sep 2011, *R.L. Thompson & K. Rivers Thompson 11-633* (BEREA, ILLS); Johnson Terrace in yard at jct 38th St., on *Juglans nigra*, 9 Dec 2011, *R.L. Thompson 11-738* (BEREA, ILLS); 229 12th St. east of Poplar St., yard of Ronnie Garrett, 37°00′7.82″N, 89°10′9.95″W, elev. 95 m, on lightly-infested planted *Betula utilis* ssp. *jacquemontii*, 25 Jun 2012, *R.L. Thompson & J.R. Abbott 12-827* (BEREA, ILLS); 424 16th St. jct. M.L. King Ave. (Walnut St.), yard of William Little, 37°00′8.39″N, 89°10′26.41″W, elev. 95 m, on planted *Broussonettia papyrifera* with six clumps, 25 Jun 2012, *R.L. Thompson & J.R. Abbott 12-830* (BEREA, ILLS); abandoned Church of Christ yard at 26th St. & Sycamore St., 37°00′33.44″N, 89°10′48.40″W, elev. 94 m, on *Ulmus americana*, 1 Apr 2013, *R.L. Thompson & W.W. Overbeck 13-63* (BEREA, ILLS); abandoned Church of Christ yard at 26th & Sycamore St., 37°00′24.75″N, 89°10′42.72″W, elev. 94 m, on *Celtis laevigata*, 1 Apr 2013, *R.L. Thompson & W.W. Overbeck 13-64* (BEREA, ILLS); abandoned Church of Christ lawn at 26th St. & Sycamore, 37°00′34.87″N, 89°10′46.78″W, elev. 94 m, on escaped *Broussonettia papyrifera*, 1 Apr 2013, *R.L. Thompson & W.W. Overbeck 13-65* (BEREA, ILLS).

APPENDIX 2

ANNOTATED ILLINOIS MISTLETOE HERBARIUM COLLECTIONS

ILLINOIS. Alexander Co.: Miller City, tree in Mississippi River bottoms, 25 Nov 1939, *R.A. Evers & F.W. Evers 93* (ILL†, ILLS); old floodplain roadside between Horseshoe Lake and the Mississippi River, on *Ulmus americana*, 18 Oct 1947, *W.M. Bailey & J.R. Swayne 256* (EIU, NCU, SIU); 1.0 mile S of Olive Branch, on *Quercus*, 10 Oct 1970, *Furray 148* (EIU); Horseshoe Lake, wet woods, Sec.7–10, 15–18, 20–22, T 16 S, R 2 W, wet bottomland woods, 5 Nov 1970, *J.S. Huston 562* (SIU); a side road off Rt. 3/127 near pond and small homes in Cache, on *Acer saccharinum*, 1 Nov 1985, *D. Nickrent & K. Robertson 2076* (ILL); Ozark Hill Prairie Research Area, Shawnee National Forest, Mill Creek 7.5-minute topo, in *Nyssa sylvatica* on steep wooded slope, 8 Apr 1992, *L.R. Phillippe & J. Olson 19792* (ILLS); Urbandale, jct. of US 51 & IL 37, 37°2′23.14″N, 89°11′10.37″W, elev. 94 m, heavily-infested *Ulmus americana*, 29 Mar 2013, *R.L. Thompson & W.W. Overbeck 13-04* (BEREA, ILLS); Urbandale, jct. of US 51 & IL 37, behind residence, 37°2′20.90″N, 89°11′15.37″W, elev. 94 m, lightly-infested *Acer saccharinum*, 29 Mar 2013, *R.L. Thompson & W.W. Overbeck 13-05* (BEREA, ILLS). **Clark Co.:** E of West Union, on *Ulmus americana*, 3 Nov 1949, *R.A. Evers 21997* (ILLS). **Crawford Co.:** SE of Palestine, on *Ulmus americana,* 26 Nov 1949, *R.A. Evers 22043* (ILLS); Palestine, on *Ulmus americana*, 26 Dec 1949, *H.E Ahles 1892* (ILL†, ISM); Sec. 2, R 11 W, T 6 N., growing on *Ulmus americana*, 29 Dec 1973, *J.E. Ebinger 14345* (EIU, ILLS). **Gallatin Co.:** 2 mi. N of Lawler, on *Ulmus*, 13 Nov 1948, *J.C. Carter s.n.* (ILLS); 3.0 mi. N of Saline Mines, on *Robinia pseudoacacia*, 10 Dec 1949, *H.E Ahles 1894* (ILL†); 1.5 mi. N of Inman; on *Ulmus americana*, 10 Dec 1949, *G.S. Winterringer 2844* (ISM); 3.0 mi. N of Saline Mines, on *Robinia pseudoacacia*, 10 Dec 1949, *G.S. Winterringer 2851* (ISM); Cave-in-Rock Road (IL 1), yard of Greg Mayne, Box 71, 37°36′03.75″N, 88°12′27.04″W, elev. 109 m, heavily-infested *Acer saccharinum*, 31 Mar 2013, *R.L. Thompson & W.W. Overbeck 13-35* (BEREA, ILLS). **Hardin Co.:** Cave-in-Rock State Park, in the SE part of Hardin Co., T 12 S, R 9 or 10 E, bordering on the N shore of the Ohio River, tree growing on the sides of the stony limestone bluffs, 11 Nov 1947, *W.M. Bailey & J.R. Swayne 292* (EIU, ILLS, NCU, SIU); 3.0 mi. from Cave-in-Rock, on *Ulmus americana*, 10 Dec 1949, *H.E Ahles 1897* (ILL†); S of Lamb, NE of Cave-in-Rock, on *Ulmus americana*, 10 Dec 1949, *G.S. Winterringer 2849* (ISM); Cave-in-Rock State Park, N of lodge, 37°28′10.65″N, 88°9′3.75″W, elev. 138 m, two small sprigs in *Nyssa sylvatica*, 31 Mar 2013, *R.L. Thompson 13-36* (BEREA); Cave-in-Rock State Park, S of lodge, 37°28′8.20″N, 88°9′7.28″W, elev. 141 m, 12–15 clumps on *Acer rubrum*, 31 Mar 2013, *R.L. Thompson 13-37* (BEREA, ILLS); Cave-in-Rock State Park, SE of lodge, 37°28′10.25″N, 88°9′2.45″W, elev. 130 m, moderately-infested *Juglans nigra*, 31 Mar 2013, *R.L. Thompson 13-38* (BEREA, ILLS); Cave-in-Rock State Park, NE of lodge, 37°28′10.88″N, 88°9′2.78″W, elev. 134 m, lightly-infested *Acer saccharum*, 31 Mar 2013, *R.L. Thompson 13-39* (BEREA, ILLS); Cave-in-Rock State Park, NW of lodge restaurant across blacktop, 37°28′8.90″N, 88°9′9.79″W, elev. 146 m, in *Fraxinus americana*, 11–15 clumps, 31 Mar 2013, *R.L. Thompson 13-40* (BEREA, ILLS); Cave-in-Rock State Park, S of visitor center on blufftop, 37°28′10.72″N, 88°9′5.92″W, elev. 120 m, on *Celtis occidentalis* with 2-3 clusters, 31 Mar 2013, *R.L. Thompson 13-41* (BEREA, ILLS); Cave-in-Rock State Park, W of lodge, 37°28′10.72″N, 88°9′5.92″W, elev. 144 m, in *Ulmus americana* with 7–10 clumps, 31 Mar 2013, *R.L. Thompson 13-42* (BEREA, ILLS). **Jackson Co.:** N of Grand Tower, on *Ulmus americana*, 12 Dec 1948, *R.A. Evers 15674* (ILLS); N of Grand Tower, on *Ulmus americana*, 12 Dec 1948, *G.S. Winterringer 1807* (ILL†, NY†); near Grand Tower, on *Ulmus americana*, 2 Nov 1949, *G.S. Winterringer 2473* (ISM); N of jct. with Rt. 144 in tree along Rt. 3, 12 Dec 1956, *R.H. Mohlenbrock 8615* (SIU); 3.0 mi. NW of jct. with Rt. 149 along N side of Rt. 3 near a homestead along hillside creek, on a large *Ulmus americana*, 1 Nov 1985, *D. Nickrent & K. Robertson 2075* (ILL); Grand tower, Redtown, S of IL 3 at Wills Rd., yard of Willie Smith at 1927 Brunkhorst Ave., 37°38′28.36″N, 89°30′37.06″W, elev. 111 m, moderately-infested *Acer saccharinum*, 30 Mar 2013, *R.L. Thompson & W.W. Overbeck 13-30* (BEREA, ILLS); IL 3 N at Box 16178 in yard, 37°43′26,65″N, 89°17′14.95″W, elev. 110 m, seven heavily-infested *Acer saccharinum*, 30 Mar 2013, *R.L. Thompson & W.W. Overbeck 13-31* (BEREA, ILLS); Murphysboro, S of IL 13 at 340 Niemann Lane near Walmart, 37°45′46.54″N, 89°17′14.95″W, elev. 118 m, moderately-infested *Nyssa sylvatica*, *R.L. Thompson & W.W. Overbeck 13-32* (BEREA, ILLS). **Johnson Co.:** SW of Belknap, on *Ulmus americana*, 11 Dec 1948, *R.A. Evers 15670* (ILLS); 0.5 mi. S of Belknap, on *Ulmus americana*, 11 Dec 1948, *G.S. Winterringer 1805* (ILL†, NY†); 4.0 mi. SW of Goreville below Draper Bluff, in rocky woods on *Quercus*, 2 Apr 1949, *G.S. Winterringer 1910* (ILL†); Lower Cache River Natural Area, T 14 S, R 3 E, Sect. 10, Karnak 7.5-minute topo map, tree near river, 30 Mar 1989, *K. Winship 1007* (ILLS); Barkhausen Cache River Wetlands Center, 200 m inside & S of county line on ditch floodplain, 37°18′30.36″N, 89°1′5.59″W, elev. 100 m, a single clump in young *Ulmus americana*, 31 Mar 2013, *R.L. Thompson & W.W. Overbeck 13-48* (BEREA, ILLS); Cache River abandoned Railroad bed adj. to S. Franklin St. between Belknap & Karnak, 37°18′38.15″N, 88°57′16.02″W, elev. 102 m, lightly-infested *Acer saccharinum* specimens obtained with shotgun, 31 Mar 2013, *R.L. Thompson & W.W. Overbeck 13-49* (BEREA, ILLS). **Lawrence Co.:** 4.0 mi. S, 0.5 mi. east of Lawrenceville, woods, in *Ulmus*, 16 Mar 1949, *J.P. Sivert s.n.* (ILL); 1.0 mi. NE of St. Francisville, on *Ulmus americana*, 11 Nov 1949, *R.A. Evers 22046* (ILLS); 1.0 mi. NE of St. Francisville, on *Ulmus americana*, 26 Dec 1949, *H.E Ahles 1891* (ILL†, ISM). **Massac Co.:** Metropolis, Ill., on *Ulmus americana*, 14 Aug 1902, *H.A. Gleason s.n.* (ILL); SE of Boaz in wet ground on *Ulmus americana*, 11 December 1948, *R.A. Evers, J. Hall, & G.S. Winterringer 15669* (ILLS, SIU); SE of Boaz, on *Ulmus americana*, 11 Dec 1948, *G.S. Winterringer 1803* (ILL†, NY†); NE of Joppa, on *Nyssa sylvatica*, 11 Dec 1949, *G.S. Winterringer 2843* (ISM); Metropolis, US 45, Fort Massac State Park, lawn at Campground space 10 R , 37°8′47.64″N, 88°42′26.52″W, elev. 102 m, four clumps in *Acer rubrum*, 31 Mar 2013, *R.L. Thompson 13-45* (BEREA, ILLS); Metropolis, Fort Massac State Park in front of Visitor Center, 37°8′41.47″N, 88°43′18.95″W, elev. 102 m, a single large cluster in *Acer rubrum*, 31 Mar 2013, *R.L. Thompson 13-46* (BEREA, ILLS); Metropolis, in yard of Wilma Flemister, 719 A, East 5th St. (US 45) tree planted in 1956–57, 37°8′44.45″N, 88°43′18.95″W, elev. 103 m, moderately-infested *Acer saccharinum*, 31 Mar 2013, *R.L. Thompson & W.W. Overbeck 13-47* (BEREA, ILLS). **Pope Co.:** Golconda Quad., R 8 E, T 12 S, on Lotton farm 1.0 mi. NE of town, on a *Gleditsia triacanthos*, 9 July 1931, *J. Schopf s.n.* (ILLS); Bay Creek bottoms east of Rose Hill, on *Ulmus americana*, 11 Dec 1948, *R.A. Evers, J. Hall, & G.S. Winterringer 15666* (ILLS); near Golconda, on *Ulmus americana*, 11 Dec 1948, *G.S. Winterringer 1806* (ILL†); N of Golconda, on *Nyssa sylvatica*, 10 Dec 1949, *G.S. Winterringer 2842* (ISM); IL 1, S of Zander's Lane, Rauch's Hill in hilly dry woods, 37°22′39.36″N, 88°29′31.45″W, elev. 138 m, on three *Nyssa sylvatica*, 31 Mar 2013, *R.L. Thompson & W.W. Overbeck 13-43* (BEREA, ILLS); Golcanda, IL 146, Patton St. off Bay City Dr., 37°21′29.20″N, 88°29′4.71″W, 147 m, in *Acer saccharinum* with 15–30 clumps, 31 Mar 2013, *R.L. Thompson & W.W. Overbeck 13-44* (BEREA, ILLS). **Pulaski Co.:** *Phoradendron flavescens*, 1860, *F. Brendel s.n.* (ILL); Villa Ridge, tree with *Phoradendron flavescens*, 1869, *Raymond s.n.* (ILL); Mounds, Ill., in low ground, on *Ulmus alata*, 1 Oct 1919, *E.J. Palmer 16638* (MO†); 2.0 mi. NW of Olmstead along highway, on *Ulmus americana*, 11 April 1939, *G.H. Boewe s.n.* (ILLS); NW of Karnak in a swamp, 14 April 1949, *R.A. Evers 15745* (ILLS); E of Karnak, on *Ulmus americana*, 11 Dec 1949, *G.S. Winterringer 2847* (ISM); S of Mounds in swamp, on *Acer saccharinum*, 10 Jun 1950, *R.A. Evers 23568* (ILLS); 1.0 mi. east of Rt. 3/127 on Ill. Rt. 3 in a field

adjacent to some homes, on *Ulmus americana*, 1 Nov 1985, *D. Nickrent & K. Robertson 2077* (ILL); Lower Cache River Natural Area, portion of Porter Ditch Rd., 30 Mar 1989, *K. Winship 1011* (ILLS); Hillerman, near 304 Tick Ridge Rd. (Co. Rd. 2), Burnett family residence, 37°14′15.60″N, 88°56′27.98″W, elev. 140 m, one canker with sprigs in *Fraxinus americana*, 31 Mar 2013, *R.L. Thompson & W.W. Overbeck 13-50* (BEREA, ILLS); Cache River along abandoned railroad (So. Franklin Rd.), near Johnson Co. boundary, 37°18′3.04″N, 88°58′4.34″W, elev. 101 m, single clump in small *Nyssa sylvatica*, 31 Mar 2013, *R.L. Thompson & W.W. Overbeck 13-51* (BEREA, ILLS); Olmstead, lawn of Olmstead Missionary Baptist Church, IL 37S & jct. of Marigold St., 37°10′28.66″N, 89°5′53.21″W, elev. 105 m, lightly-infested *Acer saccharinum* 31 Mar 2013, *R.L. Thompson & W.W. Overbeck 13-52* (BEREA, ILLS); Mounds City, off IL 37, N levee by welcome sign, 37°5′42.74″N, 89°9′16.24″W, elev. 100 m, on *Celtis occidentalis*, 31 Mar 2013, *R.L. Thompson & W.W. Overbeck 13-53* (BEREA, ILLS); Mounds City, off IL 37, N levee by welcome sign, 37°5′42.74″N, 89°9′16.24″W, elev. 100 m, on *Ulmus americana*, 31 Mar 2013, *R.L. Thompson & W.W. Overbeck 13-54* (BEREA, ILLS); Mounds City, off IL 37, N levee adj. to welcome sign, 37°5′42.74″N, 89°9′16.24″W, elev. 100 m, on *Robinia pseudoacacia*, 31 Mar 2013, *R.L. Thompson & W.W. Overbeck 13-55* (BEREA, ILLS); Mounds City, Hopkin's Rd. (Commercial Ave.) adj. by IL 37 in lowland yard, 37°5′38.86″N, 89°9′14.04″W, elev. 97 m, on *Celtis laevigata*, 31 Mar 2013, *R.L. Thompson & W.W. Overbeck 13-56* (BEREA, ILLS); Mounds City, Hopkin's Rd. (Commercial Ave.) adj. IL 37 in lowland yard, 37°5′38.86″N, 89°9′14.04″W, elev. 97 m, on *Acer saccharinum*, 31 Mar 2013, *R.L. Thompson & W.W. Overbeck 13-57* (BEREA, ILLS); Mounds City, Hopkin's Rd. (Commercial Ave.) adj. to IL 37 in lowland yard, 37°5′38.86″N, 89°9′14.04″W, elev. 97 m, seven clumps on *Gleditsia triacanthos*, 31 Mar 2013, *R.L. Thompson & W.W. Overbeck 13-58* (BEREA, ILLS); Mounds City, Illinois Ave. & Pearl St. by First Missionary Baptist Church near IL 37, 37°5′19.95″N, 89°9′44.11″W, elev. 97 m, on *Fraxinus pennsylvanica*, 31 Mar 2013, *R.L. Thompson & W.W. Overbeck 13-59* (BEREA, ILLS); Mounds, off US 51N, yard of Zack Hannan, 124 N. Spencer St. jct. Thistletown St., 37°6′55.27″N, 89°11′34.46″ W, elev. 99 m, one large branch clump on *Quercus palustris*, 1 Apr 2013, *R.L. Thompson & W.W. Overbeck 13-66* (BEREA, ILLS); Mounds, off US 51N, yard of Zack Hannan, 124 N. Spencer St. jct. Thistletown St., 37°6′54.29″N, 89°11′33.93″W, elev. 99 m, on lightly-infested *Acer rubrum*, 1 Apr 2013, *R.L. Thompson & W.W. Overbeck 13-67* (BEREA, ILLS); Mounds, off US 51N, yard of Zack Hannan, 124 N. Spencer St. jct with Thistletown St., 37°6′54.70″N, 89°11′34.46″W, elev. 99 m, small sprigs on two branches of *Acer palmatum*, 1 Apr 2013, *R.L. Thompson & W.W. Overbeck 13-68* (BEREA); Mounds, off US 51N, on *Acer saccharinum*, yard of Zack Hannan, 124 N. Spencer St. jct. Thistletown St., 37°6′54.90″N, 89°11′34.68″W, elev. 99 m, 1 Apr 2013, *R.L. Thompson & W.W. Overbeck 13-69* (BEREA, ILLS). **Randolph Co.:** 1.0 mi. NE of Fort Gage, on *Nyssa sylvatica*, 10 Dec 1949, *R.A. Evers 22056* (ILLS); SW of Ellis Grove, 18 Aug 1955, *J.O. Neill 7121* (ILLS); E of Fort Gage in barnyard, on *Nyssa sylvatica*, 19 Aug 1955, *R.A. Evers 49019* (ILLS); Chester, vicinity of cove off Rt. 3, *Phoradendron* in tree, 18 Nov 1961, *J.O. Neill 15903* (ILLS); Dupo along Ill. Rt. 3, *Ulmus americana*, 26 Nov 1961, *J.O. Neill 15904* (ILLS); 0.5 mi. west of Cora in cemetery on slope by N shoulder of Rt. 3, on *Nyssa sylvatica*, 27 Mar 1977, *P. Shildneck 9231* (ISM); Chester, lawn at 8948 Edgemont Drive off IL 3 across from Mill St., 37°53′57.61″N, 89°48′37.23″W, elev. 196 m, two small clusters in a *Nyssa sylvatica*, 30 Mar 2013, *R.L. Thompson & W.W. Overbeck 13-34* (BEREA, ILLS). **Saline Co.**: NE part of Stonefort, on *Ulmus americana*, 14 Apr 1949, *R.A. Evers & J. Hall 15731* (ILLS); Stonefort, SW corner of Saline County, in *Ulmus americana*, 11 Dec 1949, *H.E Ahles 1896* (ILL†); Stonefort, SW corner of Saline County, on *Ulmus americana*, 11 Dec 1949, *G.S. Winterringer 2848* (ISM). **St. Clair Co.:** Mascoutah, Ill., *Phoradendron flavescens*, 1862, *W. Welsch s.n.* (ILL); SW of Ellis Grove, in *Nyssa sylvatica*, 19 Aug 1955, *J.O. Neill 7121* (ISM).. **Union Co.:** Jonesboro, at the Ranger Station, on *Nyssa sylvatica*, 12 Dec 1948, *R.A. Evers 15671* (ILLS); E of Wolf Lake, on *Platanus occidentalis*, 12 Dec 1948, *R.A. Evers 15672* (ILLS); E of Wolf Lake, on *Gleditsia triacanthos*, 12 Dec 1948, *R.A. Evers 15673* (ILLS); Jonesboro, on *Nyssa sylvatica*, 12 Dec 1948, *G.S. Winterringer 1804* (ILL†); on *Gleditsia triacanthos*, 12 Dec 1948, *G.S. Winterringer 1810* (ILL); on *Platanus occidentalis*, 12 Dec 1948, *G.S. Winterringer 1811* (ILL); foresters' headquarters, on *Nyssa sylvatica*, 2 Nov 1949, *G.S. Winterringer 2471* (ISM); 0.5 mi. E of town of Wolf Lake at S end of Pine Hills on low slope, Sec. 3, T. 11 S., R. 3 W., on *Juglans nigra*, 10 Jan 1955, *F.B. Buser 5777* (ILL); Cavaness Road by 750 East State IL 3 near drainage ditch and railroad tracks, 37°28′26.96″N, 89°10′38.76″W, elev. 105 m, a single cluster in an *Acer rubrum*, 30 Mar 2013, *R.L. Thompson & W.W. Overbeck 13-27* (BEREA, ILLS); Wolf Lake, 4955 State IL 3, Murphy's family yard off Jacob St., 37°30′18.45″N, 89°26′20.14″W, elev. 107 m, a single clump on *Acer saccharinum*, 30 Mar 2013, *R.L. Thompson & W.W. Overbeck 13-28* (BEREA, ILLS); Jonesboro, off IL 146 & Main St. at USDA Shawnee National Forest, Ranger Station Picnic Shelter area, 37°27′25.51″N, 89°16′9.99″W, elev. 160 m, four clumps in a *Nyssa sylvatica*, 30 Mar 2013, *R.L. Thompson & W.W. Overbeck 13-29* (BEREA, ILLS). **Wabash Co.:** Mt. Carmel, Illinois, *Phoradendron flavescens* on *Ulmus americana*, abundant fruits ripe, 25 Dec 1882, *J. Schneck s.n.* (ILL); Mt. Carmel, Illinois, *Phoradendron flavescens* fruits all gone from cold weather effects, 15 Jan 1883, *J. Schneck s.n.* (ILL,); Mt. Carmel, Illinois, *Phoradendron flavescens* inflorescences developing, 20 Apr 1883, *J. Schneck s.n.* (ILL,); Mt. Carmel, Illinois, *Phoradendron flavescens* ovaries prominent, 26 Jun 1883, *J. Schneck s.n.* (ILL); Mt. Carmel, Illinois, *Phoradendron flavescens* very small berries, 27 Jul 1883, *J. Schneck s.n.* (ILL); Mt. Carmel, Illinois, *Phoradendron flavescens* green fruits, staminate and pistillate flowers open, 15 Sep 1883, *J. Schneck s.n.* (ILL); Mt. Carmel, Illinois, *Phoradendron flavescens* berries full grown, flowers full anthesis, 23 Oct 1883, *J. Schneck s.n.* (ILL); Mt. Carmel, Illinois, *Phoradendron flavescens* white berries ripe, 6 Dec 1883, *J. Schneck s.n.* (ILL); Mt. Carmel, Illinois, *Phoradendron flavescens* on *Ulmus americana*, Dec 1912, *Trelease s.n.* (MO); 2.0 mi. NE of Keensburg, on *Ulmus americana*, 26 Nov 1949, *R.A. Evers 22047* (ILLS); 1.5 mi. NE of Allendale, on *Ulmus americana*, 9 Dec 1949, *G.S. Winterringer 2845* (ISM); I-64E adj. to S. Water St., 2.0 km S of Grayville on Wabash River floodplain, 38°13′42.21″N, 87°59′14.80″W, elev. 124 m, one clump on *Ulmus americana*, 2 Apr 2013, *R.L. Thompson 13-70* (BEREA, ILLS). **Wayne Co.:** 5.0 mi. E of Fairfield, in *Quercus*, 20 Dec 1949, *M. Walker s.n.* (ILL); 5.0 mi. S of Fairfield along roadside, in *Gleditsia triacanthos*, 20 Oct 1958, *R.A. Evers 59540* (ILLS, MU). **White Co.:** NE of Crossville, on *Ulmus americana*, 10 Dec 1949, *H.E Ahles 1898* (ILL†); NE of Crossville, Ill. Rt. 1, on *Ulmus americana*, 10 Dec 1949, *G.S. Winterringer 2850* (ISM); S of Herald in extreme southeast corner of Williamson County, on *Ulmus americana*, 12 Dec 1949, *R.A. Evers 22059* (ILLS). **Williamson Co.:** 1.5 mi. SW of Stonefort, on *Ulmus americana*, 11 Dec 1949, *H.E Ahles 1895* (ILL†); 1.5 mi. SW of Stonefort in extreme SE corner of Williamson County, on *Ulmus americana*, 11 Dec 1949, *G.S. Winterringer 2846* (ISM); village of Crab Orchard, on *Ulmus americana*, 12 Dec 1949, *R.A. Evers 22058* (ILLS).

ACKNOWLEDGMENTS

I express my gratitude to three reviewers for their constructive comments of this manuscript as follows: J. Richard Abbott, Missouri Botanical Garden; Thomas E. Hemmerly, Middle Tennessee State University; and Barney L. Lipscomb, Botanical Research Institute of Texas. Special thanks are given to the herbarium curators

of EIU, F, ILL, ILLS, IND, ISM, MO, MU, NCU, NY, OSU, and SIU for access to mistletoe specimens and their herbarium resources. I extend appreciation to Russell J. Trites, Murray State University, for his company in the Cairo survey, and Will W. Overbeck, Eastern Kentucky University, for his keen sightings of mistletoe on the southern Illinois counties reconnaissance, and Melanie G. Bentley, Eastern Kentucky University, for preparation of the three figures.

REFERENCES

Abbott, J.R. & R.L. Thompson. 2011. New combinations in *Phoradendron leucarpum* (Viscaceae). J. Bot. Res. Inst. Texas 5:139–141.

Audubon. 2013. Mississippi Flyway. National Audubon Society, Inc., Washington D.C. U.S.A. (www.audubon.org/programs/Mississippi-flyways)

Basinger, M.A., J.S. Huston, R.J. Gates, & P.A. Robertson. 1997. Vascular flora of Horseshoe Lake Conservation Area, Alexander County, Illinois. Castanea 62:82–99.

Beadles, J.A. 1990. A history of southernmost Illinois. The Gateway Press, Des Peres, Missouri, U.S.A.

Bradsby, H.C. 1883. History of Cairo, and History of Alexander County. In: W.H. Perrin. History of Alexander, Union and Pulaski Counties, Illinois. Pp. 11–220 & Pp. 443–499. O.L. Baskin Co., Historical Publishers, Chicago, Illinois, U.S.A.

Brasier, C.M. & K.W. Buck. 2001. Rapid evolutionary changes in a globally invading fungal pathogen (Dutch Elm Disease). Biological Invasions 3:233–233.

Braun, E.L. 1950. Deciduous Forests of Eastern North America. Hafner Press, New York, New York, U.S.A.

Cain, S.A. 1930. Certain floristic affinities of the trees and shrubs of the Great Smoky Mountains and vicinity. Butler. Univ. Bot. Studies 1:129–150.

Carter, J.C. 1964. Illinois trees: their diseases. Illinois Natural History Survey, Circular 46, 3rd edition, printed with alterations, Urbana, Illinois, U.S.A.

Coder, K.D. 2008. American mistletoe (*Phoradendron serotinum* var. *serotinum*) infection in trees. Warner School of Forestry and Natural Resources, Tree Health Series (WSFNRO 8-25). University of Georgia, Athens, Georgia, U.S.A. (www.forestry.uga/edu/outreach/pubs/pdf/forestry/mistletoemonographpub08-25.pdf)

Deam, C.C. 1932. Shrubs of Indiana. Publication No. 44, revised edition, State of Indiana Department of Conservation, Division of Forestry, Indianapolis, Indiana, U.S.A.

Dodge, G. 1861. Letter of 24 December 1861 from Camp McClernand, Cairo, to Friend Danforth. In: *Rock Island Argus*, 27 December 1861. NIU Libraries Digitization Projects, Lincoln, Nebraska, U.S.A. (www.lincoln.lib.niu.edu/file.php?file=riargus12271861.html)

Dyer, J.M. 2006. Revisiting the deciduous forests of eastern North America. BioScience 56:341–352.

Ewing, Jr., P. & J.P. Roddy. 1996. Let my people go: Cairo, Illinois—1967–1973. Southern Illinois University Press, Carbondale and Edwardsville, Illinois, U.S.A.

Fenneman, N.M. 1938. Physiography of the eastern United States. McGraw-Hill Book Company, New York, New York, U.S.A.

Garman, H. 1913. Woody plants of Kentucky. Univ. Kentucky Agric. Sta. Bull. 169:3–62.

Google Earth. 2013. Cairo, Illinois, and southern Illinois county maps. Image Landsat. U.S. Dept. of State Geographer 2013.

Hall, J. 1838. Notes on the western states; containing descriptive sketches of their soil, climate, resources, and scenery. Harrison Hall, Philadelphia. In: J. White. 1997. Cache River area assessment, Vol. 2, Part II. Early accounts of the ecology of the Cache. Pp. 19–21. Critical Trends Assessment Program, Illinois Department of Natural Resources, Office of Scientific Research and Analysis, Natural History Survey Division, Champaign, Illinois, U.S.A.

Hemmerly, T.E. 1989. Mistletoe parasitism in Tennessee. J. Tennessee Acad. Sci. 64:121–122.

Hosner, J.F. & L.S. Minckler. 1963. Bottomland hardwood forests of southern Illinois—regeneration and succession. Ecology 44:29–41.

Illinois Demographics. 2013. U.S. Census 2010 Decennial Survey. Demographics of Cairo, Illinois, U.S.A. (www.illinois.demographics.com/Cairo.demographics)

Jones, G.N. 1945. Flora of Illinois. Amer. Midl. Naturalist, Monogr. 2:1–317.

Jones, G.N. 1963. Flora of Illinois, 3rd Edition. Amer. Midl. Naturalist, Monogr. 7.

Jones, G.N. & G.D. Fuller. 1955. Vascular flora of Illinois. Illinois State Museum, University of Illinois Press, Springfield, Illinois, U.S.A.

Kammerer, J.C. 1990. Largest rivers in the United States (revised). U.S. Department of the Interior, U.S. Geological Survey, Water Resources Division, Reston, Virginia, U.S.A. (www.pubs.usgs.gov/of/1987/ofr87-242/pdf/ofr8787242.pdf).

Keys, Jr., J.E., C.A. Carpenter, S.L. Hooks, F.G. Koenig, W.H. McNab, W.E. Russell, & M.L. Smith. 1995. Ecological units of the eastern U.S.—first approximation (colored map and booklet of map unit table—Map scale 3,500,000). United States Department of Agriculture, Forest Service, Atlanta, Georgia, U.S.A.

Küchler, A.W. 1964. Manual to accompany the map of potential natural vegetation of the conterminous United States. Special Publ. Amer. Geogr. Soc. 36.

Kuijt, J. 1982. The Viscaceae of the southeastern United States. J. Arn. Arbor. 63:401–410.

Kuijt, J. 2003. Monograph of *Phoradendron* (Viscaceae). Syst. Bot. Monogr. 66:1–643.

Lansden, J.M. 1910. A history of the city of Cairo, Illinois. R.R. Donnelley & Sons. Reprinted by Southern Illinois University Press, Carbondale and Edwardsville, Illinois, U.S.A.

Lantz, H.R. 1972. A community in search of itself: a case history of Cairo, Illinois. Southern Illinois University Press, Carbondale and Edwardsville, Illinois, U.S.A.

Leighton, M.M, G.E. Ekblaw, & L. Hornberg. 1993. Physiographic provinces of Illinois. Updated color map, scale 1:3,000,000. Illinois State Geological Survey, Champaign, Illinois, U.S.A. (www.isgs.illinois.edu/maps-data-pub/publications/pdf-files/physio-w-color-8x11.pdf)

Lewis, M., W. Clark, & Members of the Corps of Discovery. 2005. November 21, 1803. In: G. Moulton, ed. The journals of the Lewis and Clark Expedition. University of Nebraska Press/University of Nebraska-Lincoln Libraries-Electronic Text Center, Lincoln, Nebraska, U.S.A. (http://lewisandclarkjournals.unl.edu/read)

Midwest Regional Climate Center. 2013. Climate of the Midwest. Illinois: Cairo, Alexander County: Station 111166, Cairo 3 N. Illinois State Water Survey, Champaign, Illinois, U.S.A. (http://mrcc.isws.illinois.edu/climate_midwest/mwclimate_data_summaries.hth)

Mohlenbrock, R.H. 1990. The illustrated flora of Illinois: nightshades to mistletoe. Southern Illinois University Press, Carbondale and Edwardsville, Illinois, U.S.A.

Mohlenbrock, R.H. 2002. Vascular flora of Illinois. Southern Illinois University Press, Carbondale and Edwardsville, Illinois, U.S.A.

Mooney, J.L. 1968. Dictionary of American Naval fighting ships (DANFS), Vol. IV: L-M. Office of the Chief of Naval Operations, Naval History & Heritage Center, Washington, D.C., U.S.A. (www.history.navy.mi/danfs/m12/mistletoe-i.htm).

Nelson, W.J. 2008. Geology of the Cairo Quadrangle, Alexander and Pulaski counties, Illinois. Illinois Geologic Quadrangle Map, IGQ Cairo-G, scale 1:24,000, 2 sheets. Illinois State Geological Survey. (www.isgs.illiinois.edu/maps-data-pub/isgs-quads/c/pdf-files/cairo-g/pdf)

Omernik, J.M. 2007. Level III Ecoregions of the conterminous United States. Map (scale 1:7,500,000). National Health and Environmental Effects Research Laboratory, U.S. Environmental Protection Agency, Corvallis, Oregon, U.S.A. (www.epa.gov/wed/pages/ecoregions.htm)

Overlease, W. & E. Overlease. 2005. Our search for the mystical mistletoe: a field study of the distribution, abundance, and host species of mistletoe (*Phoradendron serotinum*) in the eastern United States. AuthorHouse Publishers, Bloomington, Indiana, U.S.A. (www.authorhouse.com)

Parks, W.D. & J.B. Fehrenbacker. 1968. Soil survey Pulaski and Alexander counties, Illinois. United States Department of Agriculture, Soil Conservation Service, and Illinois Experiment Station, No. 85. Washington, D.C., U.S.A.

Pilotlight. 2005. Historic Cairo, Illinois. (www.pilotlight2000.com/historic/index.htm)

Reveal, J.L. & M.C. Johnston. 1957. A new combination in *Phoradendron* (Viscaceae). Taxon 38:107–108.

Rosenberg, M. 2013. Köppen climate classification system. Geography and climate. (www.geography.about.com/od/physicalgeography/a/Köppen.htm)

Schneck, J. 1884a. Notes on *Phoradendron flavescens*, Nuttall I. Bot. Gaz. 9:94–96.

Schneck, J. 1884b. Notes on *Phoradendron flavescens*, Nuttall II. Bot. Gaz. 9:101–103.

Schwegman, J.E., G.B. Fell, M. Hutchinson, G. Paulson, W.H. Shepherd, & J. White. 1973. Comprehensive plan for the Illinois Nature Preserve System, Part 2. The natural divisions of Illinois. Illinois Nature Preserves Commission, Rockford, Illinois, U.S.A.

Soil Survey Staff. 2013. Cairo, Illinois, Alexander County, Illinois, U.S.A. (IL003). National Resource Conservation Service, United States Department of Agriculture. Web Soil Survey. (http://websoilsurvey.nrcs.usda.gov/app/WebSoilSurvey/aspx)

Spooner, D.M. 1983. The northern range of eastern mistletoe, *Phoradendron serotinum* (Viscaceae), and its status in Ohio. Bull. Torrey Bot. Club 110:489–493.

Taft, J. & A. Mankowski. 1997. Natural terrestrial communities/vegetation descriptions. In: A. Mankowski, D. Baker, & K. Miller, eds. Cache River area assessment, Vol. 1, Part II: Living resources. Critical Trends Assessment Program (CTAP). Illinois Department of Natural Resources, Office of Scientific Research and Analysis, Natural History Survey Division, Champaign, Illinois, U.S.A. Pp. 33–46.

Tehon, L.R. 1942. Fieldbook of native shrubs of Illinois, manual 3. Natural History Survey Division, Urbana, Illinois, U.S.A.

Thiers, B. 2014 [continuously updated]. Index Herbariorum: a global directory of public herbaria and associated staff, New York Botanical Garden's Virtual Herbarium. (http://sweetgum.nybg.org/in/).

Thompson, D.T. & G.W. Bennett. 1938. Lake management reports. 1. Horseshoe Lake near Cairo, Illinois. Biological Notes No. 8, Division of the Natural History Survey, Urbana, Illinois, U.S.A.

Thompson, R.L. 2005. Host occurrence of eastern mistletoe (*Phoradendron leucarpum*, Viscaceae) in Robertson County, Kentucky. J. Kentucky Acad. Sci. 66:137–138.

Thompson, R.L. & C.A. Evans. 2010. Eastern mistletoe (*Phoradendron leucarpum*, Viscaceae) infestation of host trees in Jessamine County, Kentucky. J. Kentucky Acad. Sci. 71:19–25.

Thompson, R.L. & R.L. Jones. 2001. Woody plants of Rock Creek Research Natural Area and watershed uplands, Laurel County, Kentucky. Castanea 66:275–287.

Thompson, R.L. & F.D. Noe, Jr. 2003. American mistletoe (*Phoradendron leucarpum*, Viscaceae) in Rockcastle County, Kentucky. J. Kentucky Acad. Sci. 64:29–35.

Thompson, R.L. & D.B. Poindexter. 2005. Host specificity of American mistletoe (*Phoradendron leucarpum*, Viscaceae) in Garrard County, Kentucky. J. Kentucky Acad. Sci. 66:40–43.

Thompson, R.L., K. Rivers Thompson, E.A. Fleming, R.D. Cooks, J.R. Price, M.N. Naseman, & A.J. Oles. 2008. Eastern mistletoe (*Phoradendron leucarpum*, Viscaceae) in the city of Berea: A high incidence of infestation and eight new host species for Kentucky. J. Kentucky Acad. Sci. 69:3–10.

Trelease, W. 1916. The genus *Phoradendron*: a monographic revision. University of Illinois, Urbana, Illinois, U.S.A.

USDA, ARS. 2013. Interactive USDA plant hardiness zone map. USDA, Agricultural Research Service. (www.planthardiness.ars.usda.gov/phzmweb/interactivemap.aspx)

USDA, NRCS. 2013. United States Department of Agriculture, Natural Resources Conservation Service. The PLANTS Database Team, Greensboro, North Carolina, U.S.A. (http://plants.usda.gov/)

Voigt, J.W. & R.H. Mohlenbrock. 1964. Plant communities of southern Illinois. Southern Illinois University Press, Carbondale, Illinois, U.S.A.

Weiser, K.R. 2012. Legends of America. Illinois legends: Cairo, Illinois—Death by racism, a travel site for the nostalgic & historic minded. (www.legendsofamerican.com/il-cairo.html)

White, J. 1997. Early accounts of the ecology of the Cache River area. Cache River area assessment, Vol. 2, Part II. Critical Trends Assessment Program (CTAP). Illinois Department of Natural Resources, Office of Scientific Research and Analysis, Natural History Survey Division, Champaign, Illinois, U.S.A.

White, J. & M.H. Madany. 1978. Classification of natural communities in Illinois, Appendix 30. In: J. White, ed. Illinois natural areas inventory technical report, Vol. 1, Survey methods and results. Illinois Natural History Inventory, Urbana, Illinois, U.S.A. Pp. 305–405.

Williams, D.R., B.C. Fitch, & S.J. Indorante. 2007. Soil survey of Alexander County, Illinois. United States Department of Agriculture and Natural Resources Conservation Service.

TETRAGONIA TETRAGONIOIDES (AIZOACEAE) DISCOVERED IN LOUISIANA, U.S.A.

Sairah M. Javed

Louisiana Natural Heritage Program
Louisiana Department of Wildlife and Fisheries
Baton Rouge, Louisiana 70898, U.S.A.
sjaved@wlf.la.gov

Lowell E. Urbatsch

Louisiana State University
Department of Biological Sciences
Baton Rouge, Louisiana 70803, U.S.A.

ABSTRACT

Tetragonia tetragonioides (Pallas) Kuntze is reported for the first time as adventive to Louisiana. This largely southern hemisphere taxon has become widespread around the World. Louisiana is added to the list of nine other states in the U.S. where this species is known to occur.

RESUMEN

Tetragonia tetragonioides (Pallas) Kuntze se registra por primera vez como especie adventicia en Louisiana. Este taxon, mayormente del hemisferio oriental, se ha dispersado ampliamente alrededor del mundo. Lousiana se agrega a la lista de los otros nueve estados en los EE.UU. donde se conoce la ocurrencia de esta especie.

The senior author discovered a single plant of *Tetragonia tetragonioides* (Pallas) Kuntze while performing a botanical survey of Grand Terre Island in Jefferson Parish, Louisiana. This species was observed growing on dry beach amongst coppice mounds between the dune ridge and the high tide line. Grand Terre is a barrier island adjacent to the Gulf of Mexico and is situated just south of Barataria Bay and northwest of the Mississippi River Delta. This represents the first report for the species in Louisiana. Because only one individual was observed, the senior author collected a fragment for a voucher specimen. Associates of this species included *Cakile* Mill., *Amaranthus gregii* S. Watson, *Sesuvium portulacastrum* (L.) L., *Spartina alterniflora* Loisel., and *Suaeda linearis* (Elliot) Moq.

The genus *Tetragonia* L. is comprised of 50–60 species, mostly of the southern hemisphere (Gathe and Watson 2008). *Tetragonia tetragonioides* is the most widespread species and is native to New Zealand and Australia (Prescott 1984); however, it can be dispersed on ocean currents and consequently may have arrived naturally to areas of South America (Fabris 1967; Taylor 1994). USDA, ARS, National Genetic Resources Program (2013) also includes China, Japan, and Taiwan within the native range of this taxon. In New Zealand, *T. tetragonioides* inhabits coastal sand dunes, bluffs, and margins of coastal wetlands (Taylor 1994; Vivrette 2008). The seeds of *T. tetragonioides* can remain viable in salt water for over one month which allows them to successfully disperse via ocean currents (Taylor 1994). Due to its apparent ease of dispersal and to anthropogenic activities, this species can be found adventively or naturalized in many parts of the World (Taylor 1994). In the U.S., *T. tetragonioides* has been introduced in California, Connecticut, Florida, Massachusetts, North Carolina, Oregon, Pennsylvania, West Virginia, and Wisconsin (USDA, ARS, National Genetic Resources Program 2013). It is considered invasive only in California, where it is given an invasiveness rating of "limited," which indicates that environmental impacts are minor to moderate, or inadequate information is available to designate a higher rating (California Invasive Plant Council 2006).

Tetragonia tetragonioides, commonly known as New Zealand spinach, is consumed by humans and cultivated as a vegetable in various countries around the World, including the United States (USDA, ARS, National Genetic Resources Program 2013; Roskruge 2011; Taylor 1994). Its flavor is similar to cultivated spinach *Spinacia oleracea* L., only milder (Roskruge 2011). Xing (2008) also reports that *T. tetragonioides* is used medicinally.

Voucher specimen: **U.S.A.: LOUISIANA: Jefferson Parish:** Grand Terre Island, growing on beach on south side of island near abandoned buildings, only one plant observed, N 29.27574, W 89.93875, elev. near sea level, 23 May 2012, *Javed* 7 (LSU, #131803).

ACKNOWLEDGMENTS

The senior author thanks Ben Stultz with the Louisiana Department of Wildlife and Fisheries for boat transportation to Grand Terre Island and for being an excellent guide. We thank David Boufford, Harvard University Herbaria, and Gustavo Heiden, Universidade de São Paulo as well as others in the Taxacom community for their expertise in identifying this species. Our gratitude also extends to Anthony Gendall and Alison Kellow of La Trobe University for helping obtain text from *Flora of Australia.* The senior author also extends a special thank you to Chris Reid of the Louisiana Natural Heritage Program for his expertise and guidance. We greatly appreciate Robert R. Haynes and Charlotte M. Taylor for their careful reviews of the manuscript.

REFERENCES

California Invasive Plant Council. 2006. California Invasive Plant Inventory Database. (http://www.cal-ipc.org/paf/). Accessed 17 December 2013.

Fabris, H.A. 1967. Aizoaceae. In: A.L. Cabrera, ed. Flora de la Provincia de Buenos Aires, vol. 3. Instituto Nacional de Tecnologia Agropecuaria, Buenos Aires, Argentina. Pp. 171–180.

Gathe, J & L. Watson. 2008. *Tetragonia* L. Western Australian Herbarium (1998–). FloraBase—the Western Australian Flora. Department of Parks and Wildlife. (http://florabase.dpaw.wa.gov.au/browse/profile/21407). Accessed 07 November 2013

Prescott, A. 1984. *Tetragonia*. In: A.S. George, ed. Flora of Australia, Vol. 4. Australian Government Publishing Service, Canberra, Australia. Pp. 37–42.

Roskruge, N. 2011. The commercialization of kōkihi or New Zealand spinach (*Tetragonia tetragonioides*) in New Zealand. Agron. New Zealand 41:149–156.

Taylor, C.M. 1994. Revision of *Tetragonia* (Aizoaceae) in South America. Syst. Bot. 19:575–589.

USDA, ARS, National Genetic Resources Program. 2013. Germplasm Resources Information Network - (GRIN) [Online Database]. National Germplasm Resources Laboratory, Beltsville, Maryland. (http://www.ars-grin.gov/cgi-bin/npgs/html/taxon.pl?36385). Accessed 07 November 2013.

Vivrette, N.J. 2008. *Tetragonia*. In: Flora of North America Editorial Committee. 1993–. Flora of North America north of Mexico. 16+ vols. Oxford University Press, New York, New York, U.S.A. 4:77–78. (http://efloras.org/florataxon.aspx?flora_id=1&taxon_id=132571). Accessed 8 July 2013.

Xing, F. 2008. Flora of China. eFloras. (http://www.efloras.org, 9 January 2014). Missouri Botanical Garden, St. Louis, Missouri, and Harvard University Herbaria, Cambridge, Massachusetts, U.S.A.

AMSONIA LUDOVICIANA (APOCYNACEAE) NEW TO THE FLORA OF TEXAS (U.S.A.)

Chris Doffitt and Charles Allen*

Colorado State Univ., Fort Polk Station
1645 23rd St.
Fort Polk, Louisiana 71459, U.S.A.
**Contact: charles.m.allen1.ctr@mail.mil*

Patricia and David Lewis

262 CR 3062
Newton, Texas 75966-7003, U.S.A.

ABSTRACT

Amsonia ludoviciana Vail, Apocynaceae is reported new to Texas based on collections from Newton County and represents the western most record of the species. The leaves are densely hairy on the abaxial surface, typical of this species.

ABSTRACT

Amsonia ludoviciana Vail, Apocynaceae se cita como nueva para Texas basada en colecciones de Newton County y representa la cita más occidental de la especie. Las hojas son densamente pelosas en el envés, típico de esta especie.

Our collections of Louisiana bluestar (*Amsonia ludoviciana* Vail) from Newton County, Texas are apparently the first report of this species for the state. It is not listed for Texas (Correll & Johnston 1970; Hatch et al 1990; Jones et al 1997; Turner et al 2003). During fieldwork for the Flora of Newton County project, we have collected specimens of the genus *Amsonia*. A sterile population (Site one) of *Amsonia* was discovered in west central Newton County in November 2009 (Allen 21841) and at a different location (Site two), a fruiting specimen was collected on June 25, 2010 (Allen 21985). Site two was revisited on April 7, 2011 and a collection of the population in flower, Allen 22212 was made. No flowering specimens have been collected at Site one. Site two is approximately 2.5 km north of site one. The leaf blades from plants at both locations are densely hairy on the abaxial surface and at site two, the flowers are hairy, both typical characteristics of *A. ludoviciana*. This species is also reported from Georgia, Mississippi, and Louisiana (USDA NRCS 2014). In Louisiana, it is reported from twelve parishes including three (Calcasieu, Sabine, and Vernon) adjacent to Texas. A. ludoviciana is ranked G3 and S2 in Georgia, S3 in Louisiana, and might be extirpated in Mississippi (Natureserve 2014). The counties in Georgia are Rockdale, DeKalb, Gwinnett, and Walton. Associated herbaceous species include *Dichanthelium acuminatum* (Sw.) Gould & C.A. Clark and *Pteridium aquilinum* (L.) Kuhn and associated woody species include *Cyrilla racemiflora* L., *Ilex opaca* Ait., *I. vomitoria* Ait., *Morella cerifera* (L.) Small, and *Nyssa biflora* Walt. Our collection is the western most record of this species in the United States.

Voucher specimens for *Amsonia ludoviciana*: **TEXAS. Newton Co.:** site 1, forest, off County Road 3107 ca 0.1 mi W of Texas 87 and ca 7.5 mi S of Bleakwood, 11 Nov 2011, *Charles Allen and Brian Early 21841* (LSU); site two, forest, off Texas 82 at State Forest ca. 3 mi W of Texas 87 and 5 mi SW of Bleakwood, 25 Jun 2010, *Charles Allen and Krisztian Megyeri 21985*, (BRIT);.same location, 7 Apr 2011, *Charles Allen 2212* (BRIT, TEX-LL).

ACKNOWLEDGMENTS

The authors would like to thank Sam Kieschnick and two anonymous reviewers for reviewing an earlier draft.

REFERENCES

Correll, D.S. & M.C. Johnston. 1970. Manual of the vascular plants of Texas. Texas Res. Found., Renner, Texas, U.S.A.

Hatch, S.L., K.N. Gandhi, & L.E. Brown. 1990. Checklist of the vascular plants of Texas. Texas Agric. Exp. Sta. Bull. MP 1655. College Station, Texas, U.S.A.

Jones, S.D., J.K. Wipff, & P.M. Montgomery. 1997. Vascular plants of Texas; a comprehensive checklist including synonymy, bibliography, and index. University of Texas Press, Austin, U.S.A.

NatureServe. 2014. NatureServe Explorer: An online encyclopedia of life [web application]. Version 7.1. NatureServe, Arlington, Virginia. Available http://www.natureserve.org/explorer. (Accessed: Aug 19, 2014).

Turner, B.L., H. Nichols, G. Denny, & O. Doron. 2003. Atlas of the vascular plants of Texas, Vol. 1. Sida, Bot. Misc. 24:1–648.

USDA, NRCS. 2014. The PLANTS Database (http://plants.usda.gov,). National Plant Data Team, Greensboro, North Carolina 27401-4901 USA.

THE VASCULAR FLORA AND PLANT COMMUNITIES OF CANDY ABSHIER WILDLIFE MANAGEMENT AREA, CHAMBERS COUNTY, TEXAS, U.S.A.

Jason R. Singhurst

Wildlife Diversity Program
Texas Parks & Wildlife Department
4200 Smith School Road, Austin, Texas 78744 U.S.A.
jason.singhurst@tpwd.state.gov

Amos Cooper

District 7, Wildlife Division
10 Parks & Wildlife Drive
Port Arthur, Texas 77640, U.S.A.

David J. Rosen

Department of Biology
Lee College
Baytown, Texas 77522-0818, U.S.A.

Walter C. Holmes

Department of Biology
Baylor University
Waco, Texas 76798-7388 U.S.A.

ABSTRACT

Field studies at the Candy Abshier Wildlife Management Area, an area of approximately 83 ha (207 acres) of the Gulf Coast Prairies and Marshes vegetation area, have resulted in a description of the vegetation associations and an annotated checklist of the vascular flora. The following four associations occur on the property: (1) the newly described Upper Texas Coast Ingleside Sandy Wet Prairie; (2) Gulf Cordgrass Herbaceous Vegetation; (3) Texas Gulf Coast Live Oak - Sugarberry Forest; and (4) natural depressional ponds. A total of 363 species belonging to 220 genera and 84 families were recorded. A total of 24 exotic plant species were recorded. The families with the largest number of species were Poaceae (63), Cyperaceae (48), Asteraceae (43), Fabaceae (14), and Juncaceae (12). *Rhynchospora chapmanii* and *Euthamia caroliniana* were recorded as new to the Texas flora. Three Texas endemic plants were present: *Thurovia triflora, Liatris bracteata*, and *Tradescantia subacaulis*, the former two being tracked as rare plants. Other noteworthy species included *Andropogon capillipes, Asclepias longifolia, Juncus elliottii, Ludwigia hirtella, Pinguicula pumila, Rhynchospora latifolia, Rhynchospora plumosa, Sabatia gentianoides*, and *Xyris stricta*.

RESUMEN

Investigaciones de campo en el Área de Manejo de Vida Silvestre, Candy Abshier Wildlife Management Area, con un área de aproximadamente 83 ha, resultaron en una descripción de las asociaciones de comunidades de vegetación y una lista anotada de la flora vascular. Son cuatro las asociaciones que ocurren en la propiedad: (1) Pradera Mojada Arenosa de la Costa Superior de Texas, Ingleside - nuevamente descrita; (2) Vegetación Herbácea de Spartina del Golfo; (3) Bosque de Quercus-Celtis del Golfo de Texas; y (4) charcos en depresiones naturales. Se documentaron un total de 363 especies de plantas que pertenecen a 220 géneros y 84 familias. Las familias con las mayores representaciones fueron Poaceae (63), Cyperaceae (48), Asteraceae (43), Fabaceae (14) y Juncaceae (12). *Rhynchopsora chapmanii* y *Euthamia caroliniana* fueron registradas por primera vez en Texas. Se encontraron tres especies endémicas: *Thurovia triflora, Liatris bracteata* y *Tradescantia subacaulis*, las primeras dos son plantas raras mantenidas en nuestra base de datos. Otras especies de interés son *Andropogon capillipes, Asclepias longifolia, Juncus elliottii, Ludwigia hirtella, Pinguicula pumila, Rhynchospora latifolia, Rhynchospora plumosa, Sabatia gentianoides* y *Xyris stricta*.

INTRODUCTION

Currently, only 1.0% (26,304 ha) of the original 2,630,456 ha of coastal prairies still remain in or near its original condition in Texas (Smeins et al. 1991). The coastal prairies, known as the Gulf Coastal Prairie and Marshes vegetational area (Gould 1960), is a region of significant plant endemism. Carr (2009) mentions 104 of the 320 Texas endemic plants as occurring in at least one location in this region. The number of vascular plant species (including introductions) in Texas varies from 4839 (Correll & Johnston 1979) to 5100 (Turner et al. 2003). MacRoberts and MacRoberts (2008) cite the number of species in the Gulf Coastal Prairies and Marshes vegetational area as 2317, showing it to be the richest in species number of any of the vegetation areas of the state. Yet, as of today, there are but few published floristic lists of portions of the area, thus indicating the area has largely been neglected.

Topography of the Gulf Coastal Prairie and Marshes vegetational area is flat to very gently rolling from the Texas-Louisiana border to Harris County (Houston). Included features are barrier islands, beaches, estuarine

lagoons, saline and brackish marshes as well as inland prairies and woodlands of various sorts. This region of the state is considered transitional and largely defined by the absence of pines, clearly distinguishing it from the adjacent Pineywoods vegetational area. Elevations are mostly less than 46 m. Most of the region is underlain by poorly consolidated clays, silts, and sands of Pleistocene or Holocene age. Nearest to the coast lies the Beaumont Formation, which often appears as a featureless plain of black clay. However, sandy materials of point bars, levees, and other depositional environments are also present. While scarcely perceptible topographically, such sands have a major effect on the local diversity of vegetation. Also of note from the city of Beaumont area is a series of former Pleistocene aged barrier islands that now lie on the current shoreline rather than offshore. A strip of the Ingleside barrier island extends through the Candy Abshier Wildlife Management Area (CAWMA) with the sands of this system supporting many species that do not occur on the Beaumont clays to the west. Inland from the Beaumont Formation is the Lissie Formation, which typically has a loamier, sandier surface and a more gently rolling topography. Both the Beaumont and Lissie formations routinely exhibit pimple mounds, several being up to 8 m in diameter and up to 1 m in height. These mounds occur throughout the prairie portion of CAWMA.

STUDY SITE

Candy Abshier was established as a wildlife management area and selected to commemorate Catherine "Candy" Cain Abshier, a former Texas Parks and Wildlife employee who promoted wetland conservation recycling and preservation of historic sites. The site was purchased in 1990. Candy Abshier Wildlife Management Area (CAWMA) is recognized as one of the most popular points on the Great Texas Coastal Birding Trail (TPWD 2012). CAWMA (TPWD 2012) is located on Galveston Bay and Trinity Bay, near Smith Point in Chambers County (Fig. 1). CAWMA ranges from a minimum of sea level to a maximum of 4 m in elevation. Climate of the region is humid subtropical (Bomar 1995) with warm summers while relative humidity is almost always high. Mean annual precipitation averages 140 cm in Chambers County. The average frost free period is 270 days in Chambers County (Natural Fibers Information Center 1987). Hurricanes are relatively rare but over time have exerted a considerable influence on regional vegetation.

The main soil type at CAWMA (Crout 1976) is the Stowell-Clodine association characterized by acid and alkaline, sandy and loamy soils. This association is slightly above sea level and has little natural drainages. The Stowell soils are on sandy ridges from 0.5 to 4 m above sea level. Clodine soils are in depressions 0.25 to 1 m above sea level. Both soils have a surface layer of very dark grey sandy clay loam from 12.7 cm to 38.1 cm in depth. A small portion of CAWMA near the western boundary consists of Veston soils, alkaline and saline soils that support aquatic and salt tolerant grasses and sedges in loamy marine sediments that were deposited by storm tides and wind action. CAWMA consists primarily of coastal prairie habitat with significant important coastal woodlot (oak mottes) and freshwater ponds. Approximately 31 ha of the area are in this oak motte habitat. The remaining area is coastal prairie (50 ha) vegetation and freshwater ponds (2 ha).

MATERIALS AND METHODS

The checklist is based upon specimens that were collected during eleven field trips that were made by two of the authors (Rosen and Singhurst) between 2008 and 2013. Collections are deposited in the Baylor University Herbarium (BAYLU) and University of Texas Herbarium (TEX-LL). The nomenclature follows Plants Database (USDA, NRCS 2014). Plants considered non-native are those that are not part of the native to the flora of Texas and we followed Plants Database (USDA, NRCS 2014).

FLORISTIC RESULTS

Dominant vegetative over story on the CAWMA (Fig. 2) consists of slender bluestem (*Schizachyrium tenerum*), little bluestem (*Schizachyrium scoparium*), brownseed paspalum (*Paspalum plicatulum*), few flowered beaksedge (*Rhynchospora rariflora*), fascicled beaksedge (*Rhynchospora fascicularis*), nutrushes (*Scleria* spp.), gulf cordgrass (*Spartina spartinae*), coastal live oak (*Quercus virginiana*), sugarberry (*Celtis laevigata*), Carolina cherry

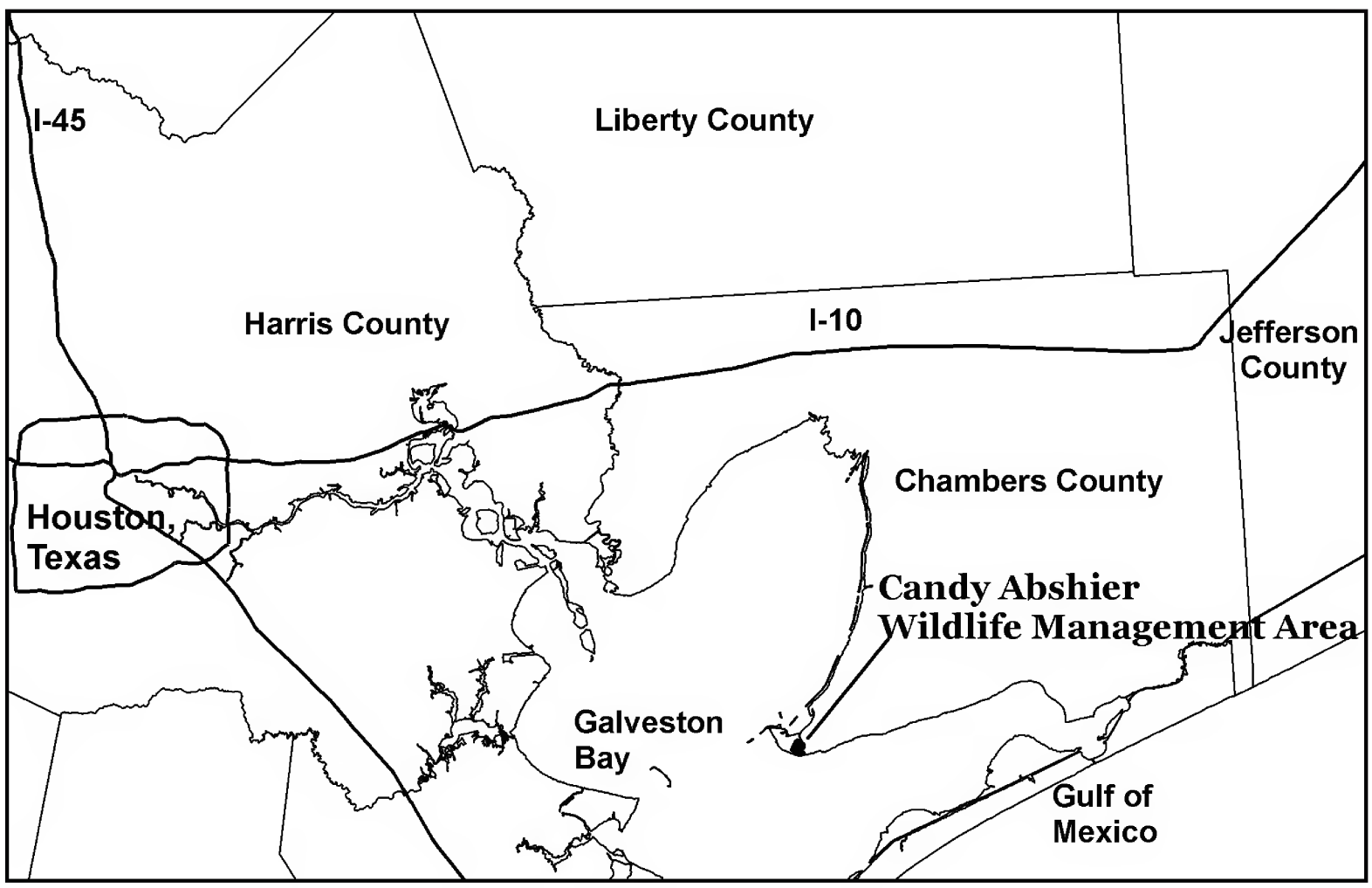


Fig. 1. Candy Abshier Wildlife Management Area, Chambers County, Texas.

laurel (*Prunus caroliniana*), and maidencane (*Panicum hemitomon*). Forbs are mostly annual and perennials with their presence being influenced by rainfall.

A total of 363 species representing 84 families and 220 genera were documented for CAWMA (Appendix 1). Of this total 33 (9.1%) are non-native species. Plant families with the largest number of species were Poaceae with 63 (17.2 %), Cyperaceae with 48 (13.1%), and Asteraceae with 43 (11.7%). Several rare and regionally significant plant species were documented. These include threeflower broom-weed (*Thurovia triflora*), bracted blazing-star (*Liatris bracteata*), and stemless spiderwort (*Tradescantia subacaulis*).

The flora of CAWMA was compared with recently published floral checklists of three coastal prairies. These include the flora of Nash Prairie (Rosen 2007) and Mowotony Prairie (Rosen 2010) in Brazoria County, both owned by the Nature Conservancy of Texas and the Warren & Jack Road Prairies (Singhurst et al. 2014) in Harris County, owned by the Katy Prairie Conservancy. The comparisons are presented in Table 1, which shows comparable naturalness represented by a low percentage of non-natives (9% or less) for all four prairie sites. This supports the importance for continued management of all four of these prairie preserves in a landscape that is highly susceptible to much higher percentages of non-native plant invasions. In summary all four of these prairies are extremely important to the conservation of the flora and associated biota of the upper coast of Texas.

PLANT COMMUNITY RESULTS

Based on dominant species, landscape position, and soil water content, four (4) plant community associations were documented at CAWMA. One association is a newly described plant community within Nature Serves classification scheme (NVCS 2014). CAWMA is herbaceous rich with 90% of the species being herbaceous annuals and perennials while only 10% consists of trees, shrubs, and woody vines. For organizational purposes, the plant community association descriptions are discussed by system categories (terrestrial and aquatic veg-

Fig. 2. Candy Abshier Wildlife Management Area Prairie Vegetation.

etation classes). Within each class, one or more associations may be present. The associations generally follow the name, a brief description of each, with emphasis on major characteristic species.

Natural Terrestrial Associations

1. Upper Texas Coast Ingleside Sandy Wet Prairie (*Schizachyrium tenerum – Rhynchospora rariflora – Rhynchospora plumosa – Rhynchospora fascicularis – Scleria* spp. Herbaceous Vegetation)

This community, which encompasses about 52 ha, is an upland coastal prairie of the West Gulf Coastal Plain with extremely rich flora diversity. The area is dominated by *Schizachyrium tenerum*, *Rhynchospora rariflora*, *Rhynchospora plumosa*, *Rhynchospora fascicularis*, and *Scleria ciliata*, *S. georgiana*, *S. pauciflora*, and *S. reticularis*. The community is developed on Stowell loamy fine sandy loam that is characterized by an abundance of pimple mounds. Extreme variability in micro-topography is typical, particularly with sandy to sandy loam soils within this prairie type. The most elevated mounds are very sandy and contain xeric sandhill flora found at the summit. The inter-mound swales vary in depth, retaining water from days to weeks after rain events, apparently caused by differential water holding capacity. In a few localized areas sandy ridges, in concert with a series of mounds, act as dry upland features with seasonal seepage migrating from the bases of ridges and mounds to lower areas that are similar to seepage bogs. These areas support such plants as *Lycopodiella alopecuroides* and *Schoenolirion croceum*.

Other characteristic flora included *Andropogon capillipes, Anthaenantia rufa, Arnoglossum ovatum, Dichanthelium acuminatum, D. scoparium, Drosera brevifolia, Eleocharis tuberculosa, Eupatorium rotundifolia, Gratiola pilosa, Helianthus angustifolia, Hyptis alata, Hypericum crux-andreae, Ludwigia hirtella, Paspalum floridanum,*

Table 1. Floristic comparison of CAWMA flora to three upper coastal prairies in Texas.

Upper Coastal Prairie	County	Hectare	Native (%)	Non-Native (%)	Total
Candy Abshier WMA (TPWD)	Chambers	83 ha	330 (90.9%)	33 (9.1%)	363
Nash Prairie (TNC)	Brazoria	120 ha	289 (89.9%)	22 (7.1%)	311
Mowotony Prairie (TNC)	Brazoria	42 ha	195 (98 %)	4 (2 %)	199
Warren & Jack Road Prairies (KPC)	Harris	321 ha	354 (93.1%)	26 (6.9%)	378

Pinguicula pumila, Polygala cruciata, Rhexia mariana, Sabatia gentianoides, Viola lanceolata, Xyris ambigua, and *X. stricta.*

2. Gulf Cordgrass Herbaceous Vegetation (*Spartina spartinae* Herbaceous Vegetation)

This community at CAWMA occurs on upland flats just above normal tidal reach and encompasses about 6 ha. *Spartina spartinae* is typically a monodominant, but *Setaria parviflora* is common and *Spartina patens* may be locally codominant. Other characteristic species included *Andropogon glomeratus*, *Cyperus* spp., *Lythrum alatum*, and *Baccharis halimifolia.* Several small patches of saline hardpans (slick spots) are embedded within this plant community. These micro-habitats are sparsely vegetated with hyper-saline flora and included the Texas endemics *Liatris bracteata* and *Thurovia triflora* (Poole et al. 2007). Additional saline flora includes *Borrichia frutescens*, *Limonium carolinianum*, *Lycium carolinianum*, *Monanthochloe littoralis*, *Salicornia depressa*, and *Spergularia marina.*

3. Texas Gulf Coast Live Oak - Sugarberry Forest (*Quercus virginiana - Celtis laevigata/Prunus caroliniana* Forest)

This association (Diamond 1993) includes woodlands occurring along the upper Gulf Coast of Texas north of Galveston Bay (Brazoria, Chambers, Galveston, and Jefferson counties, TX) on the Ingleside barrier-strand-plain, a Pleistocene barrier ridge. This community at CAWMA encompasses about 24 ha. The canopy is dominated by *Quercus virginiana*. The patchy understory contains *Ilex vomitoria* and *Prunus caroliniana*, which may also reach into the canopy. A few other oak species sporadically occur in this coastal forest and include *Quercus laurifolia*, *Q. nigra*, and *Q. phellos.* Several *Carex* spp. and *Allium canadense* are prominent in the seasonally damp shady understory during the spring and early summer.

Natural Aquatic Associations

Depressional Pond Types.—Pond flora at CAWMA encompasses about 2 ha and is variable due to differences in substrate and water depth. Pond flora is mostly centric with the deeper center of ponds dominated by emergent aquatic plants and then migrating to seasonal flooded outer edges. The deeper portions of the ponds at CAWMA included emergent aquatic flora such as *Nymphaea odorata* and *Utricularia gibba.* With water depth of 15–61 cm (6–24 inches) *Eleocharis quadrangulata*, *Juncus effusus*, *Panicum hemitomon*, *Polygonum hydropiperoides*, *Proserpenica palustris*, *Sacciolepis striata*, and *Schoenoplectus tabernaemontana* are prominent. A water depth of less than 15 cm (6 inches) is dominated by *Hydrolea ovata*, *Juncus repens*, *Juncus roemeriana*, *Ludwigia linearis*, and *Panicum rigidulum.*

DISCUSSION

The overall goal of this research was to document the flora and plant communities of CAWMA. While some data on the flora of upper coastal prairies have been collected on a few prairie sites, there is a great need to study additional prairies. Thus this work will also serve as an invitation to conduct additional studies on the coastal prairies. Southwestern Chambers County contains several small and one large (Middleton Prairie, 324 ha) intact prairies on the Ingleside geologic formation. Preliminary inventory of this prairie (Bridges et al. 2014) has documented the presence of a number of species (~15) that seemingly may be related to tract size and also blurs the distinction between coastal prairie and the adjacent piney woods. Included among these species were indicators of tall grass prairie and seasonal seepage plants more typical of Longleaf Pine Wetland Savannahs of

southeast Texas. Included were such species as *Marshallia graminifolia*, *Orbexilum simplex*, *Eriocaulon decangulare*, *Helianthus mollis*, *Asclepias obovata*, and *Rhexia lutea*. This circumstance supports a continued need for additional study of the upper coastal prairies. In conclusion, CAWMA is an extremely important coastal prairie that contains a high diversity of flora, three Texas endemic plants, and a newly described plant community association. We highly encourage further flora inventories of the coastal prairies of Texas.

APPENDIX 1. ANNOTATED CHECKLIST OF THE FLORA OF CANDY ABSHIER WILDLIFE MANAGEMENT AREA

The annotated checklist is divided into pteridophytes, gymnosperms, and angiosperms, which subdivided into monocots and dicots. Families, genera, and species are arranged alphabetically beneath each heading. Nomenclature follows USDA, NRCS (2014). Names of collectors are abbreviated as follows: DJR = David Rosen and JRS = Jason Singhurst. An asterisk (*) denotes a non-native species (species not native to Texas). Voucher specimens were verified at and deposited in the Baylor University Herbarium (BAYLU) and University of Texas Herbarium (TEX).

The checklist consists of 84 families, 220 genera, and 363 species. The families with the most species are: Poaceae (63), Asteraceae (43), Cyperaceae (48), Fabaceae (14), and Juncaceae (12).

PTERIDOPHYTES

Azollaceae
Azolla microphylla Kaulf., JRS 20660

Dennstaedtiaceae
Pteridium aquilinum (L.) Kuhn var. *psuedocaudatum*, DJR 4020, JRS 15244

Lycopodiaceae
Lycopodiella alopecuroides (L.) Cranfill, JRS 15214

Polypodiaceae
Pleopeltis polypodioides (L.) Andrews & Windham ssp. *michauxiana* (Weath.) Andrews & Windham, JRS 20663

GYMNOSPERMS

Cupressaceae
Juniperus virginiana L., JRS 16042
Taxodium distichum (L.) Rich., JRS 14931

Pinaceae
Pinus taeda L., JRS 15163

ANGIOSPERMS
MONOCOTYLEDONS

Alismataceae
Sagittaria papillosa Bunch, JRS 14971

Alliaceae
Allium canadense L., DJR 4006 & JRS 20629
Allium drummondii Regel, JRS 16053 & 20628
Nothoscordum bivalve (L.) Britt., JRS 20618

Amaryllidaceae
Cooperia drummondii Herbert, JRS 15260
Hypoxis hirsuta (L.) Coville, DJR 4026

Commelinaceae
Commelina erecta L., DJR 4346, JRS 15265
Tradescantia hirsutiflora Bush, DJR 4028, JRS 14944
Tradescantia subacaulis Bush, DJR 4025, JRS 15243

Cyperaceae
Carex complanata Torr. & Hook., DJR 4103& 4601
Carex festucacea Schkuhr ex Willd., DJR 4084
Carex longii Mack., DJR 4060
Carex tribuloides Wahlenb., JRS 14981
Cyperus articulatus L., JRS 15231
*Cyperus entrerianus** Boeckl., JRS 14976
Cyperus haspan L., DJR 4085, JRS 15226
Cyperus reflexus Vahl, DJR 4062
Cyperus strigosus L., JRS 15229
Cyperus virens Michx., JRS 14929
Eleocharis flavescens (Pour.) Urb., DJR 4814 & JRS 20601
Eleocharis macrostachya Britton, DJR 4112
Eleocharis montana (Kunth) Roemer. & Schultes, DJR 4063
Eleocharis montevidensis Kunth, DJR 4113 & JRS 20602
Eleocharis palustris (L.) Roem. & Schult., DJR 4112
Eleocharis quadrangulata (Michx.) Roemer & Schultes, JRS 20600
Eleocharis tuberculosa (Michx.) Roemer & Schultes, DJR 4073, 4017, 1019, & 4088
Fimbristylis autumnalis (L.) Roem. & Schult., DJR 4661
Fimbristylis castanea (Michx.) Vahl, JRS 14963
Fimbristylis caroliniana (Lam.) Fernald, DJR 4341
Fuirena breviseta (Coville) Coville, DJR 4304 & 4654, JRS 15213
Fuirena squarrosa Michx., JRS 20603
Isolepis carinata Hook & Arn. ex Torr., JRS 14953
Kyllinga odorata Vahl, DJR 4107, JRS 14954
Rhynchospora chapmannii M.A. Curtis, DJR 4660
Rhynchospora colorata (L.) H. Pfeiffer, JRS 14958
Rhynchospora corniculata (Lam.) A. Gray, JRS 20662
Rhynchospora debilis Gale, DJR 4094, JRS 15205
Rhynchospora divergens Chapm. ex M.A. Curtis, JRS 15205 & 16054
Rhynchospora fascicularis (Michx.) Vahl, DJR 4291 & 4293, JRS 15248
Rhynchospora filifolia A. Gray, DJR 4652
Rhynchospora globularis (Chapm.) Small var. *globularis*, DJR 4051, 4077, & 4083
Rhynchospora glomerata (L.) Vahl, JRS 15186
Rhynchospora gracilenta A. Gray, JRS 15250
Rhynchospora harveyi E. Boot., DJR 4653 & 4657
Rhynchospora inexpansa (Michx.) Vahl, DJR 4294, JRS s.n.
Rhynchospora latifolia (Baldw. ex Ell.) Thomas, JRS 15176
Rhynchospora macrostachya Torr. ex A. Gray, JRS 14972 & 15249
Rhynchospora plumosa Elliott, DJR 4068 & 4087, JRS 14959 & 15161
Rhynchospora rariflora (Michx.) Elliott, DJR 4092 & 4052, JRS 15168

Rhynchospora recognita (Gale) Kral, DJR 4093
Scleria ciliata Michx. var. *glabra* (Chapm.) Fairey, DJR 4110
Scleria georgiana Core, DJR 4057, JRS 15253
Scleria pauciflora Muhl. ex Willd. var. *pauciflora*, DJR 4067, JRS 15204
Scleria reticularis Michx., DJR 4295, 4342,& 4648, JRS 15273
Scleria triglomerata Michx., JRS 15180
Schoenoplectus californicus (C.A. Mey.) Palla, JRS 20659
Schoenoplectus tabernaemontani (K.C. Gmel.) Palla, JRS 20661

Iridaceae
Sisyrinchium atlanticum Bickn., DJR 4009, JRS 14943 & 16055
Sisyrinchium minus Engelm. & A. Gray, DJR 4080, JRS 14942

Juncaceae
Juncus brachycarpus Engelm., DJR 4003 & 4808
Juncus bufonius L., DJR 4676, JRS 16059
Juncus coriaceus Mackenzie, JRS 14980
Juncus dichotomus Elliott, DJR 4075, JRS 14973
Juncus elliottii Chapm., DJR 4082, JRS 14921
Juncus effusus L., DJR 4670
Juncus marginatus Rostk., DJR 4081, JRS 15192 & 15221
Juncus polycephalus Michx., JRS 15190
Juncus repens Michx., DJR4816
Juncus roemerianus Scheele, DJR 4066
Juncus tenuis Willd., JRS 15202
Juncus validus Coville var. *validus*, DJR 4297, JRS 14967 & 15295

Melanthiaceae
Schoenolirion croceum (Michx.) Wood, JRS 20658

Orchidaceae
Spiranthes cernua (L.) Rich., JRS s.n.
Spiranthes praecox (Walter) S. Watson, DJR 4058, JRS 14979

Poaceae
Agrostis hyemalis (Walter) Britton, Sterns & Poggenb., DJR 4004, JRS 14957
Andropogon capillipes Nash (syn = *Andropogon virginicus* var. *glaucus*), JRS 20567
Andropogon glomeratus (Walter) Britton, Sterns & Poggenb., JRS 20655
Andropogon ternarius DJR 4647 Michx., JRS 20656
Andropogon virginicus L. var. *virginicus*, DJR 4646
Anthaenantia villosa (Michx.) P. Beauv., JRS 20654
Aristida lanosa Muhl. ex Ell., JRS 20653
Aristida longespica Poir., JRS 20652
Aristida purpurascens Poir., DJR 4649
Axonopus fissifolius (Raddi) Kuhlm., DJR 4022, JRS 15219
Axonopus furcatus (Flueggé) Hitchc., DJR 4659
Bothriochloa laguroides (DC.) Herter, JRS 20650
*Briza minor** L., JRS 14937
*Bromus catharticus** Vahl, DJR 4680
Cenchrus spinifex Cav., JRS 15281
*Chloris gayana** Kunth, JRS 14955
*Cynodon dactylon** (L.) Pers., JRS 14946
Dichanthelium aciculare (Desv. ex Poir.) Gould & C.A. Clark subsp. *aciculare*, DJR 4050, 4016, 4053, & 4099, JRS 15252
Dichanthelium acuminatum (Sw.) Gould & C.A. Clark subsp. *acuminatum*, DJR 4049, 4055, & 4086
Dichanthelium acuminatum (Sw.) Gould & C.A. Clark subsp. *lindheimeri* (Nash) Freckmann & Lelong, DJR 4111, JRS 15247
Dichanthelium portoricense (Desv. ex Ham.) B.F. Hansen & Wunderlin, DJR 4054
Dichanthelium consanguineum (Kunth) Gould & C.A. Clark, DJR 4070
Dichanthelium oligosanthes (Schult.) Gould subsp. *scribnerianum* (Nash) Freckmann & Lelong, DJR 4008
Dichanthelium scabriusculum (Ell.) Gould & C.A. Clark, JRS 20664
Dichanthelium scoparium (Lam.) Gould, DJR 4096, JRS 15175
Dichanthelium sphaerocarpon (Elliott) Gould, DJR 4102
Dichanthelium tenue (Muhl.) Freckmann & Lelong, DJR 4071
Distichlis spicata (L.) Greene, JRS 20649
Elymus virginicus L., JRS 20651
Eragrostis elliottii S. Watson, DJR 4655
Eragrostis lugens Nees., DJR 4658
Eragrostis refracta (Muhl.) Scribn., DJR 4662
Eragrostis spectabilis (Pursh) Steud., JRS 20648
Eragrostis secundiflora Presl ssp. *oxylepis* (Torr.) S.D. Koch., JRS 15188
Eustachys petraea (Sw.) Desv., DJR 4106
Leersia hexandra Sw., DJR 4072
Monanthochloe littoralis Engelm., JRS 15242
Muhlenbergia capillaris (Lam.) Trin., JRS 20609
Panicum anceps Michx., JRS 15194
*Panicum repens** L., DJR 4064
Panicum rigidulum Nees, JRS 15234
*Paspalum dilatatum** Poir., JRS 15237
Paspalum floridanum Michx., DJR 4340, JRS 15187
Paspalum minus E. Fourn., DJR 4305
Paspalum monostachyum Vasey, DJR 4667 & JRS 20599
Paspalum plicatulum Michx., DJR 4098, JRS 15182
Paspalum setaceum Michx., JRS 4668
*Paspalum urvillei** Steud., JRS 15238
Panicum verrucosum Muhl., DJR 4662
*Poa annua** L., DJR 4677
*Polypogon monspeliensis** (L.) Desf., JRS 16063
Sacciolepis striata (L.) Nash, DJR 4651, JRS 15294
Schizachyrium tenerum Nees, DJR 4296, JRS 15288
Schizachyrium scoparium (Michx.) Nash, DJR 4666
Setaria parviflora (Poir.) Kerguelén, JRS 15236
Sorghastrum nutans (L.) Nash, DJR 4665
Spartina patens (Ait.) Muhl., JRS 15199
Spartina spartinae (Trin.) Merr. ex Hitchc., JRS 15195 & 15169
Sporobolus pyramidatus (Lam.) Hitchc., JRS 20610
Sporobolus virginicus (L.) Kunth, JRS 15224
*Stenotaphrum secundatum** (Walt.) Kuntze, JRS 15191
Tridens strictus (Nutt.) Nash, JRS 20647
Vulpia octoflora (Walter) Rydb. var. *octoflora*, DJR 4076

Smilacaceae
Smilax bona-nox L., JRS 14910 & 15170
Smilax glauca Walt., JRS 15290 & 14922
Smilax smallii Morong, JRS 15255

Typhaceae
Typha domingensis Pers., JRS 15228

Xyridaceae
Xyris ambigua Kunth, JRS 15208
Xyris jupicai Rich., DJR 4306
Xyris stricta Chapm., DJR, 4292, JRS 15203

DICOTYLEDONS

Acanthaceae
Dyschoriste linearis (Torr. & A. Gray) Kuntze, DJR 4747
Ruellia humilis Nutt., JRS 15013 & 15206

Altingiaceae
Liquidambar styraciflua L., JRS 16061

Apiaceae
Ammoselinum butleri (S. Watson) J.M. Coult. & Rose, DJR 4012
Chaerophyllum tainturieri Hook. var. *tainturieri,* DJR 4674
Centella erecta (L.) Fern., JRS 15258 & 14917
Hydrocotyle bonariensis Comm. ex Lam., JRS 15223
Hydrocotyle umbellata L., DJR 4091

Limnosciadium pinnatum (Engelm. & A. Gray) Math. & Const., JRS 14960
Trepocarpus aethusae Nutt. ex DC., JRS 14938

Apocynaceae
Asclepias longifolia Michx., DJR 4823, JRS 15293
Asclepias vericillata L., JRS 14918
Cynanchum angustifolium Pers., JRS 15266

Aquifoliaceae
Ilex vomitoria Walt., JRS 14903

Asteraceae
Ambrosia artemisiifolia L., JRS 15230
Aphanostephus skirrhobasis (DC.) Trel., JRS 15285
Arnoglossum ovatum (Walt.) H.E. Robins., JRS 15178
Baccharis halimifolia L., JRS 15198
Bigelowia nuttallii L.C. Anders., JRS 15167
Boltonia diffusa Ell., DJR 4029 & JRS 14915 & 15173
Borrichia frutescens (L.) DC., JRS 15268 & 15012
Cirsium horridulum Michx., JRS 16060
Conoclinium coelestinum (L.) DC., JRS 20646
Coreopsis basalis (A. Dietr.) S.F. Blake, DJR 4105, JRS 14925 & 15261
Coreopsis tinctoria Nutt., JRS 14974 & 5280
Erigeron tenuis Torr. & A. Gray, DJR 4015
Eupatorium compositifolium Walt., JRS 15257
Eupatorium glaucescens Ell., DJR 4299 & JRS 15183
Eupatorium rotundifolium L., DJR 4298 & JRS 15254
Euthamia caroliniana (L.) Greene ex Porter & Britton, JRS 15467
Euthamia leptocephala (Torr. & A. Gray) Greene ex Porter & Britt., JRS 20646
Eurybia hemispherica (Alexander) Nesom, JRS 20645
*Facelis retusa** (Lam.) Sch. Bip., JRS 20626
Gaillardia pulchella Foug., JRS 15216
Gamochaeta purpurea (L.) Cabrera, DJR 4104
Helianthus angustifolia L., DJR 4343 & JRS 15174
Heterotheca subaxillaris (Lam.) Britt. & Rusby, JRS 15179 & 16056
Iva angustifolia Nutt. ex DC., JRS 20644
Iva annua L., JRS 20643
Krigia dandelion (L.) Nutt., JRS 14948
Liatris acidota Engelm. & A. Gray, DJR 4349 & JRS 15184
Liatris bracteata Gaiser, JRS 15172
Palafoxia hookeriana Torr. & A. Gray, JRS 20667
Pityopsis graminifolia (Michx.) Nutt., JRS 20666
Pluchea rosea Godfrey, DJR 4300
Pluchea foetida (L.) DC., JRS 15165
Pyrrhopappus carolinianus (Walter) DC., JRS 16041
Rudbeckia hirta L., JRS 15165
Solidago sempervirens L., JRS 20604
Solidago odora Ait., JRS 20642
Solidago rugosa Mill., JRS 20641
Solidago tortifolia Ell., DJR 4023 & JRS 14965
*Soliva sessilis** Ruiz & Pav., JRS 20627
*Sonchus asper** (L.) Hill, JRS 14935
Symphyotrichum dumosum (L.) Nesom var. *dumosum*, JRS 20671
Verbesina virginica L., JRS 20614

Brassicaceae
Cardamine pennsylvanica Muhl. Ex. Willd., JRS 20607
Lepidium densiflorum Schrad., JRS 16046
Lepidium virginicum L., JRS14952 & 16042

Cabombaceae
Cabomba caroliniana A. Gray, JRS *20597*

Campanulaceae
Lobelia appendiculata A. DC., JRS 20592
Lobelia puberula Michx., DJR 4663, JRS 20633
Triodanis perfoliata (L.) Nieuw., JRS 14936

Cannabaceae
Celtis laevigata Willd., JRS 2063

Caprifoliaceae
*Lonicera japonica** Thunb., JRS 14901
Sambucus nigra L., JRS 20617

Caryophyllaceae
*Arenaria serpyllifolia** L., JRS 20620
*Cerastium glomeratum** Thuill., DJR 4673 & JRS 20605
Silene antirrhina L., JRS 14907 & 16051
Spergularia salina J. Presl & C. Presl., DJR 4013
*Stellaria media** (L.) Vill., DJR 4678

Chenopodiaceae
Salicornia depressa Standl., JRS 14977

Clusiaceae
Hypericum drummondii (Grev. & Hook.) Torr. & A. Gray, JRS 20640
Hypericum crux-andreae (L.) Crantz, DJR 4350, JRS 14902
Hypericum galioides Lam., DJR 4807
Hypericum gymnanthum Engelm. & A. Gray, DJR 4095
Hypericum hypericoides (L.) Crantz, DJR 4348, JRS 14919 & 15251
Hypericum mutilum L., JRS 20639
Hypericum punctatum Lam., DJR 4824

Convolvulaceae
Evolvulus sericeus Sw., DJR 4014
Ipomoea sagittata Poir., JRS 15189

Cuscutaceae
Cuscuta cuspidata Engelm., JRS 15262

Droseraceae
Drosera brevifolia Pursh, DJR 4032

Ebenaceae
Diospyros virginiana L., JRS 14909

Euphorbiaceae
Chamaesyce maculata (L.) Small, JRS 15232
Croton glandulosa L., JRS 15185
*Triadica sebifera** (L.) Small, JRS 14905 &15220

Fabaceae
Baptisia bracteata Muhl. ex Elliott var. *leucophaea* (Nutt.) Kartesz & Gandhi, DJR 4021, JRS 15200
Centrosema virginianum (L.) Benth., DJR 4347, JRS 15217
Chamaecrista fasciculata (Michx.) Greene, DJR 4344, JRS 15210
Crotalaria sagittalis L., DJR 4109
Desmanthus illinoensis (Michx.) McM. ex B.L. Rob. & Fern., JRS 15235
*Medicago lupulina** L., DJR 4675
*Medicago polymorpha** L., JRS 16050
*Melilotus officinalis** (L.) Lam, JRS 14961
Mimosa hystricina (Small ex Britt. & Rose) B.L. Turner, DJR 4822, JRS 15177
Neptunia pubescens Benth., JRS 15287
*Sesbania punicea** (Cav.) Benth., DJR 4351
Tephrosia onobrychoides Nutt., JRS 20638
Vicia ludoviciana Nutt., JRS 14939
Vicia minutiflora Dietr., JRS 14949

Fumariaceae
Corydalis micrantha (Engelm. ex A. Gray) A. Gray, JRS *20606*

Fagaceae
Quercus laurifolia Michx., JRS 14913
Quercus nigra L., JRS 14911
Quercus nuttallii Palmer, JRS 14930

Quercus phellos L., JRS 14927
Quercus virginiana P. Mill., JRS 14912

Gentianaceae
*Centaurium pulchellum** (Sw.) Druce, DJR 4010, JRS 14962
Eustoma exaltatum (L.) Salisb. ex G. Don ssp. *exaltatum*, JRS 15241
Sabatia campestris Nutt., JRS 14966
Sabatia gentionoides Ell., JRS 15211 & DJR 4813

Geraniaceae
Geranium carolinianum L., JRS 14945 & 16049

Haloragaceae
Proserpinaca palustris L., DJR 4815 & 4811, JRS 20668

Hydrophyllaceae
Hydrolea ovata Choisy., JRS 15222

Juglandaceae
Carya aquatica (Michx. f.) Nutt., JRS 15245

Lamiaceae
Hyptis alata (Raf.) Shinners, JRS 15279
Hedeoma hispida Pursh, JRS 20619
Monarda punctata L., JRS 15181
Physostegia intermedia (Nutt.) Engelm. & A. Gray, DJR 4089
Physostegia pulchella C. L. Lundell, JRS 14978
Salvia lyrata L., JRS 16064
Scutellaria integrifolia L., JRS 20611

Lauraceae
*Cinnamomum ca*mphora* (L.) J. Presl, JRS 14926
Persea borbonia (L.) Spreng., JRS 20608
Sassafras albidum (Nutt.) Nees, JRS 20634

Lentibulariaceae
Pinguicula pumila Michx., DJR 4027
Utricularia gibba L., DJR 4817, JRS 20637
Utricularia subulata L., DJR 4031, JRS 14934

Linaceae
Linum medium (Planch.) Britton var. *texanum* (Planch.) Fernald, DJR 4302, 4078, JRS 15177 & 15263
Linum striatum Walt., JRS 15196
Linum sulcatum Riddell, JRS 16040

Loganiaceae
Gelsemium sempervirens (L.) J. St.-Hil., DJR 4672
Mitreola sessilifolia (J.F.Gmel) G. Don, JRS 15209

Lythraceae
Lythrum alatum Pursh, JRS 14975 & 15239
Lythrum lineare L., JRS 15272

Malvaceae
Hibiscus lasiocarpos Cav., JRS 1520
Malvaviscus arboreus Dill. ex Cav., JRS 20621
Sida rhombifolia L., JRS 14947 & 15215

Melostomataceae
Rhexia mariana L., JRS 15207

Myricaceae
Morella caroliniensis (P. Mill.) Small, JRS 15246
Morella cerifera (L.) Small, DJR 4018, JRS 14904

Nymphaeaceae
Nymphaea odorata Aiton, DJR 4818, JRS 20598

Nyssaceae
Nyssa sylvatica Marsh., JRS 15193

Onagraceae
Gaura lindheimeri Engelm. & A. Gray, JRS 15162
Ludwigia glandulosa Walter, JRS 4812
*Ludwigia grandiflora** (M. Micheli) Greuter & Burdet ssp. *grandiflora*, JRS 15227
Ludwigia hirtella Raf., JRS 15256
Ludwigia linearis Walter, DJR 4352
Oenothera heterophylla Spach, JRS 15225
Oenothera laciniata Hill, DJR 4679
Oenothera linifolia Nutt., DJR 4005
Oenothera speciosa Nutt., JRS 14956, 20613

Orobanchaceae
Agalinis fasciculata (Ell.) Raf., DJR 4097, JRS 15164 & 15283
Agalinis martitima (Raf.) Raf., JRS 20612
Agalinis purpurea (L.) Pennell, JRS 20669
Buchnera americana L., DJR 4079, JRS 14924 & 15286
Castilleja indivisa Engelm., JRS 20622

Oxalidaceae
Oxalis dillenii Jacq., JRS 16044
Oxalis violacea L., JRS 20670

Phytolaccaceae
Phytolacca americana L., JRS 15282

Plantaginaceae
Mecardonia acuminata (Walt.) Small, JRS 20636
Nuttallanthus canadensis (L.) Sutton, JRS 14940 & 20631
Plantago pusilla Nutt., JRS 16045
*Plantago lanceolata** L., JRS 14950
Plantago virginica L., DJR 4011
Veronica peregrina L., JRS 20623

Plumbaginaceae
Limonium carolinianum (Walt.) Britt., JRS 15267

Polygalaceae
Polygala cruciata L., DJR 4345, JRS 15292
Polygala leptocaulis Torr. & A. Gray, JRS 15259
Polygala mariana Mill., DJR 4108

Polygonaceae
Polygonum hydropiperoides Michx., JRS 14906
*Rumex crispus** L., JRS 16052
Rumex hastatulus Baldw., JRS 14941

Portulacaceae
Claytonia virginica L., JRS *20630*
Phemeranthus parviflorus (Nutt.) Kiger, JRS *15269 & 14968*

Primulaceae
*Anagallis arvensis** L., JRS 15278
Anagallis minima (L.) Krause, R 4024, JRS 14982

Ranunculaceae
Anemone berlandieri Pritz., JRS *20625*
Ranunculus hispidus Michx., JRS *20624*

Rosaceae
Prunus caroliniana (Mill.) Ait., JRS 14933
*Rosa bracteata** J.C. Wendl., JRS 14923
*Rosa laevigata** Michx., DJR 4669
Rubus arguta Link, JRS 15166
*Rubus riog*randis Bailey, JRS 14916

Rubiaceae
Diodia teres Walt., JRS s.n.
Diodia virginiana L., JRS 15264
Galium aparine L., JRS 16048
Galium tinctorium L., JRS 14900
Houstonia pusilla Schoepf, JRS 20595
Houstonia micrantha (Shinners) Terrell, JRS 20593

Houstonia rosea (Raf.) Terrell, JRS 20594
Oldenlandia uniflora L., DJR 4100 & JRS 15284
*Sherardia arvensis** L., DJR 4681

Rutaceae
Zanthoxylum clava-herculis L., DJR 4819

Salicaceae
Salix nigra Marshall, DJR 4806

Sapotaceae
Sideroxylon lanuginosum Michx. JRS *20591*

Saxifragaceae
Lepuropetalon spathulatum Elliott, JRS *20596*

Scrophulariaceae
Gratiola brevifolia Raf., JRS 14920 & 15291
Gratiola pilosa Michx., DJR 4303, JRS 14914 & JRS 15212

Solanaceae
Lycium carolinianum Walt., JRS 14969 & 15271
Physalis angulata L., JRS 15276
Solanum ptycanthum Dunal, JRS 16057

Tetrachondraceae
Polypremum procumbens L., DJR 4301, JRS 15275

Ulmaceae
Ulmus crassifolia Nutt., JRS 20616

Valerianaceae
Valerianella radiata (L.) Dufr., JRS 16047

Verbenaceae
*Lantana camara** L., JRS 14900
Phyla lanceolata (Michx.) Greene, JRS 14964 & 15240
*Verbena brasiliensis** Vell., JRS 14951
Verbena halei Small, JRS 14928

Violaceae
Viola lanceolata L., DJR 4030, JRS 15289
Viola sororia Willd., JRS 20632

Vitaceae
Ampelopsis arborea (L.) Koehne, JRS 15277 & 14932
Vitis rotundifolia Michx., DJR 4820
Vitis mustangensis Buckl., JRS 15233

ACKNOWLEDGMENTS

We are indebted to Michael Warriner, John Davis, Lynn Polasek, and David Forrester, all of Texas Parks and Wildlife Department (TPWD, Austin) for suggesting and supporting this project. The careful reviews of Mike Palmer and Larry E. Brown are greatly appreciated.

REFERENCES

Bomar, E.G. 1995. Texas weather. University of Texas Press, Austin, U.S.A.

Bridges, E.L., S.L. Orzell, K. Kindsher, & J.M. Poole. 2014. Middleton Prairie flora: Plant Resources Center Flora of Texas Database. University of Texas, Austin, U.S.A. http://orchid.biosci.utexas.edu/Texas_II.html

Carr, W.R. 2009. No place but Texas: Annotated list of plant taxa endemic to the Lone Start State. Incomplete working draft, The Nature Conservancy of Texas, San Antonio. U.S.A.

Correll, D.S. & M.C. Johnston 1979. Manual of the vascular plants of Texas. Texas Research Foundation, Renner, U.S.A.

Crout, J.D. 1976. Soil survey of Chambers County, Texas. United States Department of Agriculture, Soil Conservation Service, U.S.A.

Diamond, D.D. 1993. Classification of the plant communities of Texas (series level). Unpublished document. Texas Natural Heritage Program, Austin, U.S.A.

Gould, F.W., G.O. Hoffman, & C.A. Rechenthin. 1960. Vegetation areas of Texas. Texas Agricultural Experimental Station, Leaflet No. 492, Texas A&M Univ., College Station, U.S.A.

Jones, S.D., J.K. Wipff, & P.M. Montgomery. 1997. Vascular plants of Texas. University of Texas Press, Austin, U.S.A.

MacRoberts, M.H & B.R. MacRoberts. 2008. Species richness of vegetational areas of Texas: A first approximation. J. Bot. Res. Inst. Texas 2(2):1373–1379.

National Vegetation Classification System. 2014. Nature Serve Explorer, Ecological Classifications <http://www.natureserve.org/explorer/classeco.htm>

Natural Fibers Information Center. 1978. The climates of Texas counties. Austin Bureau of Business Research, University of Texas, Austin, U.S.A.

Poole, J.M., W.R. Carr, D. Price, & J.R. Singhurst. 2007. A field guide to the rare plants of Texas. Texas A&M Press, College Station, U.S.A.

Rosen, D.J. 2007. The vascular flora of Nash Prairie a Coastal Prairie remnant in Brazoria County, Texas. J. Bot. Res. Inst. Texas 1(1):679–692.

Rosen, D.J. 2010. The vascular plants of Mowotony Prairie: A small remnant coastal grassland in Brazoria County, Texas. J. Bot. Res. Inst. Texas 4(1):489–495.

Singhurst, J.R., D.J. Rosen, & W.C. Holmes. 2009. Two new additions to the vascular flora of Texas. Phytologia 91(1):69–72.

Singhurst, J.R., N. Shackelford, W. Newman, J.N. Mink, & W.C. Holmes. 2014. The ecology and abundance of *Hymenoxys texana* (Asteraceae). Phytoneuron 2014-19:1–19.

Smeins, F.E., D.D. Diamond, & C.W. Hanselka. 1991. Coastal prairie. In: R.T. Coupland, ed. Ecosystems of the world: Natural grasslands: Introduction and western hemisphere. Elsevier, New York, U.S.A. Pp. 269–290.

Texas Parks and Wildlife Department. 2012. http://www.tpwd.state.tx.us/huntwild/hunt/wma/find_a_wma/list/?id=36

Turner, B.L., H. Nichols, G. Denny, & O. Doron. 2003. Atlas of the vascular plants of Texas. Sida, Bot. Misc. 24. (2 vols.). Botanical Research Institute of Texas, Fort Worth, U.S.A.

USDA, NRCS. 2014. The PLANTS Database (http://plants.usda.gov, 22 July 2014). National Plant Data Team, Greensboro, North Carolina, U.S.A.

United States Fish and Wildlife Service. 1999. Paradise lost: The coastal prairies of Louisiana and Texas. U.S. Geological Survey Office. Baton Rouge, Louisiana, U.S.A.

ANNOUNCEMENTS

2014 DELZIE DEMAREE TRAVEL AWARD RECIPIENT

The 26th Annual Delzie Demaree Travel Award was presented at the 61st Annual Systematics Symposium (10–11 Oct 2014) at the Missouri Botanical Garden, St. Louis. One student was presented the Travel Award: Keir Michael Wefferling, University of Wisconsin-Milwaukee.

The 2014 Travel Awards were underwritten by 1) Contributors to the Delzie Demaree Travel Award Endowment, and 2) Members of the Delzie Demaree Travel Award Committee.

Anyone interested in making a contribution to Delzie Demaree Endowment Fund, which supports the travel award, may make contributions by VISA or MasterCard or by a check, payable to Botanical Research Institute of Texas, to Barney Lipscomb, 1700 University Drive, Fort Worth, TX 76107-3400, U.S.A. 1-817-332-7432; Email: barney@brit.org. Thank you.

THE 2015 APPLICATIONS FOR THE DELZIE DEMAREE TRAVEL AWARD

Applications for the 2015 Delzie Demaree Travel Award should include a letter from the applicant telling how symposium attendance will benefit his/her graduate work and letter of recommendation sent by the major professor. Please send letters of application to: Dr. Donna M.E. Ware, P.O. Box 8795, Herbarium, Biology Department, The College of William and Mary, Williamsburg, Virginia 23185-8795, U.S.A. 1-757-221-2799; Email: ddmware@wm.edu. Applications may be sent to: Barney Lipscomb, 1700 University Drive, Fort Worth, Texas 76107-3400, U.S.A. 1-817-332-7432; Email: barney@brit.org. The period for receiving applications will end three weeks prior to the date of the symposium if a sufficient number of applications are in hand at that time. Anyone wishing to apply after that date should inquire whether applications are still being accepted before applying. The Systematics Symposium dates for 2015 are 9–10 October 2015 (dates tentative and subject to change).

The Delzie Demaree Travel Award was established in 1988 honoring **Delzie Demaree** who attended 35 out of a possible 36 symposia before he died in 1987. Delzie Demaree was a frontier botanist, explorer, discoverer, and teacher. His teaching career as a botanist began in Arkansas at Hendrix College in 1922. He also taught botany at the University of Arkansas, Navajo Indian School, Yale School of Forestry, Arkansas A&M, and Arkansas State University at Jonesboro where he retired as professor emeritus in 1953. One of the things he enjoyed most as a botanist was assisting students with their field botany research.

IN MEMORIAM
LANDON E. McKINNEY
(1949–2014)

Ronald L. Jones

Eastern Kentucky University Herbarium
Richmond, Kentucky 40475, U.S.A.

Ralph L. Thompson

Berea College Herbarium
Berea, Kentucky 40404, U.S.A.

Landon E. McKinney, a talented field botanist and naturalist, passed away on Thursday, June 5th, 2014, at the Wade Park Veteran's Medical Center in Cleveland, Ohio, at the age of 65. Landon Earl McKinney was born May 17, 1949 in Nashville, Tennessee, to the late Lawrence Vern and Constance Joy McKinney. After graduating from Donelson High School in Nashville in 1967, Landon joined the Navy and served as a Marine Navy Corpsman from 1968–1970; he was a field combat corpsman in Vietnam during 1969. He earned a B.S. in Biology in 1973 from Middle Tennessee State University (MTSU) and subsequently his M.S. in Botany in 1977 from MTSU. His master's thesis was "*Preliminary Studies of the Acaulescent Blue Violets (Viola) with Special Reference to Middle Tennessee,*" which began his life-long fascination with the stemless blue violets. He was a Research Associate in Plant Taxonomy at Vanderbilt University from 1985–1989, where he worked with Dr. Robert Kral.

After his family, Landon's true passion was botany, which he focused upon throughout his life. He served as a field botanist for the Tennessee Natural Heritage Program and the Kentucky State Nature Preserves Commission, and worked as an environmental consultant for several different companies in the eastern U.S., mostly in Kentucky, Ohio, and Tennessee. He conducted numerous status surveys for state and federal rare plant species, worked on habitat analyses, assessed wetland communities, and made management recommendations on preserving natural habits and controlling invasive species. In recent years he established research affiliations with Northern Kentucky University, University of Cincinnati, and Ohio State University.

Landon was active in the Tennessee Academy of Science and the Kentucky Academy of Science, serving

J. Bot. Res. Inst. Texas 8(2): 677 – 678. 2014

terms as Chair and Secretary for both academies. In 2003–2005, he was a member of the Editorial Board of *Castanea, Journal of the Southern Appalachian Society*, and served as Chair in 2005–2006. Landon was heavily involved in the Kentucky Native Plant Society (KNPS) for many years; he regularly attended annual meetings and frequently led field trips. He served as the KNPS President from 1992–1996 and from 2002–2006, and his strong leadership was instrumental in maintaining and enhancing the activities of the society.

Landon was an avid plant collector throughout his career and collected thousands of specimens during all his botanical activities and deposited them at regional herbaria such as EKY, TENN, and VDB. Landon eagerly collected difficult grasses, rushes, and sedges, and possessed a special skill in identifying these problematic species. Landon was especially skillful in *Carex* and *Viola*, and provided the keys to these two genera for the 2005 book, *Plant Life of Kentucky: An Illustrated Guide to the Vascular Flora*. Landon's primary passion throughout his career was the genus *Viola,* particularly the stemless blue violets, where he was nationally known for his expertise. The seminal publication of his career occurred in 1992 with a book on the stemless blue violets—*A Taxonomic Revision of the Acaulescent Blue Violets* (*Viola*) *of North America,* published by the Botanical Research Institute of Texas. This work is highly regarded and had a great influence on subsequent studies of this group of violets, with other experts often citing Landon's work and comparing it to their interpretations. Landon authored or co-authored approximately 50 scientific publications and professional presentations on *Viola* and on a variety of other topics. He was a frequent presenter at the Annual Meetings of the Association of Southeastern Biologists, Kentucky Academy of Science, and Tennessee Academy of Science.

Landon continued his work and interest in *Viola* until the very end with the completion of his work with R. John Little on the Violaceae for the *Flora of North America* which is now "in press." This past April, Landon sent an email to local botanists concerning the recent discovery of a new Kentucky county record for *Viola egglestonii*, and noted, … "after 40+ years of working with violets, violets still excite me … this population is as classical cedar glade violet as you can get …"

Landon is survived by his devoted wife of 31 years, Lela; children Adam McKinney, Amanda (Troy) Chitwood, and Eric (Amy) McKinney; grandchildren Landon, Lucas, Erica, Katelyn, and Whitney. Landon will be sadly missed by his many extended family members, special friends, and botanical colleagues.

Reviewers
Volume 8 (2014)

120 reviewers: several individuals reviewed more than one manuscript.
We sincerely apologize if your name was accidently left out.
Thank you for supporting *Journal of the Botanical Research Institute of Texas*.

Abbott, J. Richard
Acedo, Carmen
Alexander, Jason A.
Alexander, Patrick
Almeda, Frank
Al-Shehbaz, Ihsan
Anderson, Loran C.
Baker, Brent Travis
Balslev, Henrik
Barker, Robyn M.
Barrie, Fred R.
Binder, Manfred
Boyd, Steve
Brown, Larry E.
Bryson, Charles T.
Budke, Jean C.
Cantino, Philip D.
Carlquist, Sherwin
Carmo E. Amaral, Maria do
Carr, Bill
Carter, J.R.
Chorghe, Alok
Colín, Rafael Torres
Cox, Pat
Darwin, Steven P.
Daschowdhury, Sangita
Dickinson, Timothy A.
Downie, Stephen R.
Duling, Darrin W.
Eliasson, Uno
Escobar Lechuga, Roberto
Estes, Dwayne
Estrada-Castillón, Eduardo
Fertig, Walter
Feuillet, Christian
Fleming, Gary
Franck, Alan
Freeman, Craig C.
Gandhi, Kanchi
Greuter, Werner
Hammel, Barry
Haynes, Robert R.
Hemmerly, Thomas E.
Henderson, Andrew
Henrickson, James
Herrera Arrieta, Y.
Hill, Steve
Hodgson, Wendy C.
Hogan, Tim
Holst, Bruce K.
Horn, Charles N.
Iganci, João Ricardo
Jaramillo, Patricia
Jarvis, C.E.
Ju, Yu-Ming
Kawasaki, Lucia
Keener, Brian R.
Keith, Eric L.
Kieschnick, Sam R.
Kirkbride, Jr., Joseph H.
Klitgaard, B.B.
Kriebel, Ricardo
Lammers, Thomas G.
Landrum, Leslie R.
Le Roux, M. Marianne
León de la Luz, José Luis
Lipscomb, Barney
Lorence, David H.
MacDougal, John
MacRoberts, Michael
Mansfield, Don
McDonald, Andrew
McMullen, Conley K.
Meyer, Harry
Miller, Joseph T.
Moore, Gerry
Morton, Cynthia M.
Nelson, Allan D.
O'Kane, Steve
Palmer, Mike
Pennington, T.D.
Pilz, George E.
Pipoly III, John
Poindexter, Derick B.
Powell, A. Michael
Rabeler, Richard K.
Rehman, Tiana
Reveal, James L.
Riefner, Rick
Rogers, Jack D.
Rondeau, Renee
Rosen, David J.
Rundel, Phil
Rye, Barbara L.
Saarela, Jeffery M.
Salywon, Andrew
Sánchez-González, Arturo
Schlessman, Mark A.
Schwartzberg, Ezra
Serviss, Brett
Sirotnak, Joe
Skog, Laurence E.
Spaulding, Daniel Dieter
Steinmann, Victor
Suarez Suarez, Luz Stella
Swadek, Rebecca K.
Swenson, Ulf
Taylor, Charlotte M.
Tepe, Eric
Traverse, Alfred
Turner, Billie
Ulloa, Carmen
Utteridge, Timothy M.A.
Villaseñor Rios, José L.
Vincent, Michael A.
Vovides, Andrew
Weldy, Troy
Wilson, Andy
Wunderlin, Richard P.
Zarucchi, James L.

Index to 65 Titles with 144 Authors
Volume 8 (2014)

We know you have a choice.
Thank you for choosing and supporting *Journal of the Botanical Research Institute of Texas.*

A floristic inventory of Dagny Johnson Key Largo Hammock Botanical State Park and immediately adjacent lands (Monroe County), Florida, U.S.A. by George J. Wilder, Susan V. Sprunt, Janice A. Duquesnel, and Susan F. Kolterman—**8(1):227**

A gasteroid fungus, **Palaeogaster micromorpha** gen. & sp. nov. (Boletales) in Cretaceous Myanmar amber by George O. Poinar, Jr., Dônis da Silva Alfredo, and Iuri Goulart Baseia—**8(1):139**

A morphologically based taxonomic reevaluation of the genus **Stipulicida** (Caryophyllaceae), with comments on rank by Derick B. Poindexter, Kateland E. Bennett, and Alan S. Weakley—**8(2):419**

A new hedge-nettle (**Stachys:** Lamiaceae) from South Carolina, U.S.A. by John B. Nelson and Douglas A. Rayner—**8(2):25**

A new species of **Cremosperma** (Gesneriaceae) from northeastern Peru by Brian R. Keener and John L. Clark—**8(1):57**

A new species of **Garnotia** (Poaceae) from Kerala, India by C.N. Sunil, V.V. Naveen Kumar, and M.G. Sanilkumar—**8(2):517**

A new variety of **Phanera glauca** subsp. **tenuiflora** (Fabaceae: Caesalpinioideae) from India by Rajib Gogoi and Subir Bandyopadhyay—**8(1):71**

A quantitative study of the vegetation surrounding populations of **Zigadenus densus** (Melianthiaceae) at Fort Polk in west central Louisiana, U.S.A. by Jacob Delahoussaye, Charles Allen, Stacy Huskins, and Ariel Dauzart—**8(1):253**

A quantitative study of the vegetation surrounding populations of **Uvularia sessilifolia** (Colchicaceae) at Fort Polk in west central Louisiana, U.S.A. by Ariel Dauzart, Charles Allen, Stacy Huskins, and Jacob Delahoussaye—**8(1):261**

Addendum to the vascular flora of Nash Prairie, Texas, U.S.A. by David J. Rosen—**8(1):381**

Agave × madrensis (Asparagaceae), a putative hybrid from the Sierra Madre Oriental, Mexico by José A. Villarreal Quintanilla, Abraham Ramírez Gámez, Eduardo Estrada Castillón, Dino U. González Uribe, and Diana Jasso de Rodríguez—**8(2):441**

American mistletoe (**Phoradendron leucarpum** ssp. **leucarpum**, Viscaceae) occurrence in host trees within the city of Cairo, Alexander County, Illinois, and its incidence in Illinois, U.S.A. by Ralph L. Thompson—**8(2):641**

Amsonia ludoviciana (Apocynaceae) new to the flora of Texas, U.S.A. by Chris Doffitt, Charles Allen, Patricia Lewis, and David Lewis—**8(2):663**

An annotated flora of Reed Plateau and adjacent areas, Brewster County, Texas, U.S.A. by Wendy Weckesser and Martin Terry—**8(1):353**

Blyxa aubertii (Hydrocharitaceae) new to Mississippi, U.S.A. by Daniel M. McNair and Mac H. Alford—**8(1):267**

Browneopsis puyensis (Leguminosae: Caesalpinioideae: Detarieae), a new species from Amazonian Ecuador by David A. Neill and Mercedes Asanza—**8(2):511**

Calathea cofaniorum and **C. shishicoensis**, new endemic species of Marantaceae from Ecuador by Helen Kennedy—**8(1):37**

Calathea gordonii (Marantaceae), a new endemic Panamanian species by Helen Kennedy—**8(1):31**

Calathea rubribracteata, a new endemic species of Marantaceae from Colombia by Helen Kennedy—**8(2):493**

Cyperus stewartii (Cyperaceae), a new species from Cocos Island, Costa Rica by Gordon C. Tucker—**8(1):25**

Distigouania irregularis (Rhamnaceae) gen. et sp. nov. in Mid-Tertiary amber from the Dominican Republic by Kenton L. Chambers and George O. Poinar, Jr.—**8(2):551**

Dos nuevas especies de **Myrcia** (Myrtaceae), del Pacífico sur de Costa Rica by Daniel Santamaria Aguilar, Armando Estrada Ch. y Reinaldo Aguilar—**8(2):449**

Ecology and conservation of **Acacia** and **Prosopis** (Fabaceae) woodlands of the Mojave Desert, U.S.A. by Scott R. Abella and Kenneth L. Chittick—**8(1):175**

Errata: Four new annual species of **Euphorbia** section **Tithymalus** (Euphorbiaceae) from North America by Mark H. Mayfield—**8(1):85**

Estructura de un zacatal de toboso (**Hilaria mutica:** Poaceae) asociado a sustrato ígneo en el noreste de Coahuila, México by Juan A. Encina-Domínguez, Jesús Valdés-Reyna y José A. Villarreal-Quintanilla—**8(2):583**

Expanded distribution of **Gratiola quartermaniae** (Plantaginaceae) in Texas, U.S.A. by Kimberly Norton Taylor and Robert J. O'Kennon—**8(1):333**

First valid place of publication of **Duchesnea** indica (Rosaceae: Potentilleae) by James L. Reveal and Barbara Ertter—**8(1):83**

Five new Myrtaceae from southeastern Brazil by Marcos Sobral, Marcelo da Costa Souza, Ludovic Jean Charles Kollmann, Osny Tadeu Aguiar, André Luís Casarin Rochelle, and Kelly Antunes—**8(2):497**

Flora of the halophytic grasslands in the Valle de Janos, Chihuahua, Mexico José Humberto Vega-Mares, Andrés Eduardo Estrada-Castillón, José Ángel by Villarreal-Quintanilla, and Gustavo Quintana Martínez—**8(1):151**

Floristic studies in north central New Mexico, U.S.A. The Sangre de Cristo Mountains by Jill Larson, Brian Reif, B.E. Nelson, and Ronald L. Hartman—**8(1):271**

Glossoloma velutinum (Gesneriaceae), a new species from the Cordillera Central of the Colombian Andes by Larri A. Rodas and John L. Clark—**8(1):43**

Hexasepalum teres (Rubiaceae), a new combination by Joseph H. Kirkbride, Jr.—**8(1):17**

Jarilla chocola (Caricaceae), un nuevo género y especie para la flora de El Salvador by Frank Sullyvan Cardoza Ruiz, José Ledis Linares y Ana Eugenia Aguilar Grijalva—**8(2):595**

Landon E. McKinney (1949–2014) by Ronald L. Jones and Ralph L. Thompson—**8(2):677**

Limitations to natural production of **Lophophora williamsii** (Cactaceae) III. Effects of repeated harvesting at two-year intervals for six years in a South Texas (U.S.A.) population by Martin Terry, Keeper Trout, Bennie Williams, Teodoso Herrera, and Norma Fowler—**8(2):541**

Lomatium swingerae: a new species of **Lomatium** (Umbelliferae) from the Joseph Plains, Idaho, U.S.A. by Richard P. McNeill—**8(2):395**

Low genetic diversity and poor dispersal, but not conservation status rank, are linked to climate change vulnerability by Cynthia M. Morton and Matthew D. Schlesinger—**8(1):305**

New geographical and morphological data for **Sideroxylon reclinatum** subspecies **austrofloridense** (Sapotaceae), a taxon endemic to southeastern peninsular Florida, U.S.A. by Paul T. Corogin and Walter S. Judd—**8(2):403**

New species and combinations in **Solanum** section **Androceras** (Solanaceae) by Stephen R. Stern, Lynn Bohs, and Jeffrey Keeling—**8(1):1**

Noteworthy vascular plant collections from the Red River of

Arkansas and Louisiana, U.S.A. by Christopher Reid and M. Jerome Lewis—**8(1):197**

Passiflora soliana, una especie nueva de **Passiflora** (Passifloraceae) del Pacífico Sur de Costa Rica by Armando Estrada Ch. & Gerardo Rivera—**8(1):19**

Pleurisanthes flava (Icacinaceae): A new record for Brazil by Bruno S. Amorim, Rodrigo Duno de Stefano, and Marccus Alves—**8(1):169**

Primer registro de **Astrocasia peltata** (Euphorbiaceae) en Costa Rica by Irene Calderón Sanou—**8(1):165**

Recent findings on the gypsum flora of the rim of the Guadalupe Mountains, New Mexico, U.S.A.: A new species of **Nerisyrenia** (Brassicaceae), a new state record, and an updated checklist by Patrick J. Alexander, Norman A. Douglas, Helga Ochoterena, Hilda Flores-Olvera, and Michael J. Moore—**8(2):383**

Redescubrimiento y nuevos registros de **Cuscatlania vulcanicola** (Nyctaginaceae) para El Salvador by José Ledis Linares, Frank Sullyvan Cardoza Ruiz y Patricia Hernández-Ledesma—**8(2):603**

Sedum kiersteadiae (Crassulaceae), a newly described species from the Klamath Region of California, U.S.A. by Barbara L. Wilson, Richard E. Brainerd, and Nick Otting—**8(1):9**

Synopsis of **Galvezia** (Plantaginaceae: Antirrhineae), including a new cryptic species from southern Peru by Michael O. Dillon and Victor Quipuscoa Silvestre—**8(1):47**

Taxonomic status of **Kobresia curvata** and **Kobresia fragilis** (Cyperaceae) by Bikash Jana and R.C. Srivastava—**8(1):77**

Taxonomic studies in the Miconieae (Melastomataceae). XII. Revision of **Miconia** sect. **Miconiastrum**, with emphasis on the **Miconia bicolor** complex by Walter S. Judd, James Dan Skean, Jr., Eldis R. Bécquer, and Lucas C. Majure—**8(2):457**

Tetragonia tetragonioides (Aizoaceae) discovered in Louisiana, U.S.A. by Sairah M. Javed and Lowell E. Urbatsch—**8(2):661**

The first naturalized occurrence of the Cannaceae family in the Arkansas (U.S.A.) flora, with additional new and noteworthy angiosperm records for the state by Brett E. Serviss, James H. Peck, and Tiffany A. Graves—**8(2):637**

The floral structure of three weedy species of **Sida** (Malvaceae) by Junior Cezar Muneratto, Luiz Antonio de Souza, and Odair José Garcia de Almeida—**8(1):127**

The genus **Echinacea** (Asteraceae): Floral, stem, and petiole morphology by Harold W. Keller—**8(1):87**

The vascular flora and plant communities of Candy Abshier Wildlife Management Area, Chambers County, Texas, U.S.A. by Jason R. Singhurst, Amos Cooper, David J. Rosen, and Walter C. Holmes—**8(2):665**

The vascular flora of Fort Sumter and Fort Moultrie, South Carolina, U.S.A. by Richard Stalter, Brent A. Berger, Eric E. Lamont, and John Nelson—**8(1):319**

The vascular flora of Galveston Island State Park, Galveston County, Texas, U.S.A. by David J. Rosen, Shiron K. Lawrence, and Andrew Sipocz—**8(1):339**

Three new species of **Senegalia** (Fabaceae) from Brazil by David S. Seigler, John E. Ebinger, Petala Gomes Ribeiro, and Luciano Paganucci De Queiroz—**8(1):61**

Ticodendron palaios sp. nov. (Ticodendraceae), a Mid-Tertiary fossil flower in Dominican amber by Kenton L. Chambers and George O. Poinar, Jr.—**8(2):559**

Tripogon malabarica (Poaceae: Chloridoideae: Chlorideae: Tripogoninae), a new species from Kerala, India by Thoiba Kottekkattu and A.K. Pradeep—**8(2):523**

Variability of vegetative flush colors in **Zamia** (Cycadales) by Claudia Calonje, Lindy Knowles, Michael Calonje, and Chad Husby—**8(2):531**

Vascular plant flora of the alpine zone in the Southern Rocky Mountains, U.S.A. by James F. Fowler, B.E. Nelson, and Ronald L. Hartman—**8(2):611**

Vegetation and vascular flora of tallgrass prairie and wetlands, Black Squirrel Creek drainage, south-central Colorado: Perspectives from the 1940s and 2011 by Sylvia Kelso, Leah Fugere, Miroslav Kummel, and Sebastian Tsocanos—**8(1):203**

Vegetation patterns in the Mediterranean-desert ecotone of Baja California, Mexico by Sula Elizabeth Vanderplank, Jose Delgadillo, Exequiel Ezcurra, and Lucinda A. McDade—**8(2):565**

Wandersong (Rubiaceae), a new genus from the Greater Antilles by David W. Taylor—**8(2):529**

Xylaria antiqua sp. nov. (Ascomycota: Xylariaceae) in Dominican amber by George O. Poinar, Jr.—**8(1):145**

Index of 144 Authors
Volume 8 (2014)

Thank you for choosing *Journal of the Botanical Research Institute of Texas*.

Abella, Scott R.—**8(1):175**
Aguilar Grijalva, Ana Eugenia—**8(2):595**
Aguilar, Reinaldo—**8(2):449**
Alexander, Patrick J.—**8(2):383**
Alford, Mac H.—**8(1):267**
Allen, Charles—**8(1):253, 261; 8(2):663**
Alves, Marccus—**8(1):169**
Amorim, Bruno S.—**8(1):169**
Antonio de Souza, Luiz—**8(1):127**
Antunes, Kelly—**8(2):497**
Asanza, Mercedes—**8(2):511**
Bandyopadhyay, Subir—**8(1):71**
Bécquer, Eldis R.—**8(2):457**
Bennett, Kateland E.—**8(2):419**
Berger, Brent A.—**8(1):319**
Bohs, Lynn—**8(1):1**
Calderón Sanou, Irene—**8(1):165**
Calonje, Claudia—**8(2):531**
Calonje, Michael—**8(2):531**
Cardoza Ruiz, Frank Sullyvan—**8(2):595, 603**
Casarin Rochelle, André Luís—**8(2):497**
Cezar Muneratto, Junior—**8(1):127**
Chambers, Kenton L.—**8(2):551, 559**
Chittick, Kenneth L.—**8(1):175**
Clark, John L.—**8(1):43, 57**
Cooper, Amos—**8(2):665**
Corogin, Paul T.—**8(2):403**
Costa Souza, Marcelo da—**8(2):497**
Dauzart, Ariel—**8(1):253, 261**
Delahoussaye, Jacob—**8(1):253, 261**
Delgadillo, Jose—**8(2):565**
Dillon, Michael O.—**8(1):47**
Doffitt, Chris—**8(2):663**
Douglas, Norman A.—**8(2):383**
Duno de Stefano, Rodrigo—**8(1):169**
Duquesnel, Janice A.—**8(1):227**
Ebinger, John E.—**8(1):61**
Encina-Domínguez, Juan A.—**8(2):583**
Ertter, Barbara—**8(1):83**
Estrada Ch., Armando—**8(1):19; 8(2):449**
Estrada-Castillón, Andrés Eduardo—**8(1):151; 8(2):441**
Ezcurra, Exequiel—**8(2):565**
Flores-Olvera, Hilda—**8(2):383**
Fowler, James F.—**8(2):611**
Fowler, Norma—**8(2):541**
Fugere, Leah—**8(1):203**
Garcia de Almeida, Odair José—**8(1):127**
Gogoi, Rajib—**8(1):71**
Gomes Ribeiro, Petala—**8(1):61**
González Uribe, Dino U.—**8(2):441**
Goulart Baseia, Iuri—**8(1):139**
Graves, Tiffany A.—**8(2):637**
Hartman, Ronald L.—**8(1):271; 8(2):611**
Hernández-Ledesma, Patricia—**8(2):603**
Herrera, Teodoso—**8(2):541**
Holmes, Walter C.—**8(2):665**
Husby, Chad—**8(2):531**
Huskins, Stacy—**8(1):253, 261**
Jana, Bikash—**8(1):77**
Jasso de Rodríguez, Diana—**8(2):441**
Javed, Sairah M.—**8(2):661**
Jones, Ronald L.—**8(2):677**
Judd, Walter S.—**8(2):403, 457**
Keeling, Jeffrey—**8(1):1**
Keener, Brian R.—**8(1):57**
Keller, Harold W.—**8(1):87**
Kelso, Sylvia—**8(1):203**
Kennedy, Helen—**8(1):31, 37; 8(2):493**
Kirkbride, Jr., Joseph H.—**8(1):17**
Knowles, Lindy—**8(2):531**
Kollmann, Ludovic Jean Charles—**8(2):497**
Kolterman, Susan F.—**8(1):227**
Kottekkattu, Thoiba—**8(2):523**
Kumar, V.V. Naveen—**8(2):517**
Kummel, Miroslav—**8(1):203**
Lamont, Eric E.—**8(1):319**
Larson, Jill—**8(1):271**
Lawrence, Shiron K.—**8(1):339**
Lewis, David—**8(2):663**
Lewis, M. Jerome—**8(1):197**
Lewis, Patricia—**8(2):663**
Linares, José Ledis—**8(2):595, 603**
Majure, Lucas C.—**8(2):457**
Mayfield, Mark H.—**8(1):85**
McDade, Lucinda A.—**8(2):565**
McNair, Daniel M.—**8(1):267**
McNeill, Richard P.—**8(2):395**
Moore, Michael J.—**8(2):383**
Morton, Cynthia M.—**8(1):305**
Neill, David A.—**8(2):511**
Nelson, B.E.—**8(1):271; 8(2):611**
Nelson, John B.—**8(1):319; 8(2):25**
O'Kennon, Robert J.—**8(1):333**
Ochoterena, Helga—**8(2):383**
Otting, Nick—**8(1):9**
Paganucci De Queiroz, Luciano—**8(1):61**
Peck, James H.—**8(2):637**
Poinar, Jr., George O.—**8(1):139, 145; 8(2):551, 559**
Poindexter, Derick B.—**8(2):419**
Pradeep, A.K.—**8(2):523**
Quintana Martínez, Gustavo—**8(1):151**
Quipuscoa Silvestre, Victor—**8(1):47**
Ramírez Gámez, Abraham—**8(2):441**
Rayner, Douglas A.—**8(2):25**
Reid, Christopher—**8(1):197**
Reif, Brian—**8(1):271**
Reveal, James L.—**8(1):83**
Richard E. Brainerd—**8(1):9**
Rivera, Gerardo—**8(1):19**
Rodas, Larri A.—**8(1):43**
Rosen, David J.—**8(1):339, 381; 8(2):665**
Sanilkumar, M.G.—**8(2):517**
Santamaria Aguilar, Daniel—**8(2):449**
Schlesinger, Matthew D.—**8(1):305**
Seigler, David S.—**8(1):61**
Serviss, Brett E.—**8(2):637**
Silva Alfredo, Dônis da—**8(1):139**
Singhurst, Jason R.—**8(2):665**
Sipocz, Andrew—**8(1):339**
Skean, Jr., James Dan—**8(2):457**
Sobral, Marcos—**8(2):497**
Sprunt, Susan V.—**8(1):227**
Srivastava, R.C.—**8(1):77**
Stalter, Richard—**8(1):319**
Stern, Stephen R.—**8(1):1**
Sunil, C.N.—**8(2):517**
Tadeu Aguiar, Osny—**8(2):497**
Taylor, David W.—**8(2):529**
Taylor, Kimberly Norton—**8(1):333**
Terry, Martin—**8(1):353; 8(2):541**
Thompson, Ralph L.—**8(2):641, 677**
Trout, Keeper—**8(2):541**
Tsocanos, Sebastian—**8(1):203**
Tucker, Gordon C.—**8(1):25**
Urbatsch, Lowell E.—**8(2):661**
Valdés-Reyna, Jesús—**8(2):583**
Vanderplank Sula Elizabeth—**8(2):565**
Vega-Mares, José Humberto—**8(1):151**
Villarreal Quintanilla, José A.—**8(1):151; 8(2):441, 583**
Weakley, Alan S.—**8(2):419**
Weckesser, Wendy—**8(1):353**
Wilder, George J.—**8(1):227**
Williams, Bennie—**8(2):541**
Wilson, Barbara L.—**8(1):9**

Botanical Names and Subject Index
Volume 8 (2014)
New names (52) in bold face

Acacia—8(1):175
Achnatherum nelsonii var. nelsonii (new state record for New Mexico)—8(1):271
Agave—8(2):441
× madrensis—8(2):**443**
gentryi—8(2):441
lechuguilla—8(2):441
Aizoaceae—8(2):661
Alexander County (Illinois, U.S.A.)—8(2):641
Amazonian (Ecuador)—8(2):511
Amber
Dominican—8(1):145
Myanmar—8(1):139
American mistletoe—8(2):641
Andes (Colombian)—8(1):43
Androceras (sect.)—8(1):1
Antirrhineae—8(1):47
Apiaceae—8(2):383
Arizona (U.S.A.)—8(2):611
Arkansas (U.S.A.)—8(2):637
Artemisia borealis ssp. borealis (new state record for New Mexico)—8(1):271
Ascomycota—8(1):145
Asparagaceae—8(2):441
Asteraceae—8(1):87
Astrocasia peltata (new record for Costa Rica)—8(1):165
Bahamas—8(2):531
Baja California (Mexico)—8(2):565
Black Squirrel Creek Drainage (Colorado, U.S.A.)—8(1):203
Blyxa aubertii (new state record for Mississippi)—8(1):267
Boletales—8(1):139
Brassicaceae—8(2):383
Brazil—8(1):61, 169; 8(2):497
Brewster County, Texas (U.S.A.)—8(1):359
Browneopsis
puyensis—8(2):**511**
Cactaceae—8(2):541
Caesalpinioideae—8(1):71; 8(2):511
Cairo (Illinois, U.S.A.)—8(2):641
Calathea
basiflora—8(1):31
cofaniorum—8(1):**37**
fredii—8(1):37; 8(2):493
gordonii—8(1):31
neillii—8(1):37
rubribracteata—8(2):**493**
shishicoensis—8(1):41; 8(2):493
timothei—8(2):493
trianae—8(2):493
California—8(1):9
Calyptranthes
solitaria—8(2):**498**
ubatubana—8(2):**500**
Candy Abshier Wildlife Management Area (Texas, U.S.A.)—8(2):665
Canna indica (new record for Arkansas)—8(2):637
Cannaceae—8(2):637
Carex
deweyana var. deweyana (new state record for New Mexico)—8(1):271
gynocrates (new state record for New Mexico)—8(1):271
rosea (new state record for New Mexico)—8(1):271
Caricaceae—8(2):595
Caryophyllaceae—8(2):419
Central America—8(1):25
Chambers County (Texas, U.S.A.)—8(2):665
Chione—8(2):529
exserta—8(2):529
seminervis—8(2):529
Chlorideae—8(2):523
Chloridoideae—8(2):523
Climate Change—8(1):305
Coahuila (Mexico)—8(2):583
Cocos Island (Costa Rica)—8(1):25
Colchicaceae—8(1):261
Colleteria—8(2):529
Colombia—8(1):43; 8(2):493
Colombian Andes—8(1):43
Colorado (U.S.A.)—8(1):203; 8(2):611
Conservation—8(1):305
Cordillera Central (Colombia)—8(1):43
Costa Rica—8(1):25, 165; 8(2):449
Pacífico Sur de—8(1):19
Crassulaceae—8(1):9
Cremosperm
inversum—8(1):**57**
Crepis tectorum (new state record for New Mexico)—8(1):271
Cretaceous Myanmar Amber—8(1):139
Cuscatlania vulcanicola (new record for El Salvador)—8(2):603
Cycadales—8(2):531
Cymopterus spellenbergii (new state record for New Mexico)—8(1):271
Cyperaceae—8(1):25, 77
Cyperus
lentiginosus—8(1):28
panamensis—8(1):28
stewartii—8(1):**25**
Dagny Johnson Key Largo Hammock Botanical State Park (Florida, U.S.A.)—8(1):227
Dalea lanata (new record for Louisiana)—8(1):197
Dead-Man's fingers—8(1):145
Detarieae—8(2):511
Deutzia scabra—8(2):637
Diodella—8(1):17
Diodia teres—8(1):17
Distigouania—8(2):551, **552**
irregularis—8(2):**552**
Dominican Amber—8(1):145; 8(2):559
Dominican Republic—8(2):551
Draba nemorosa var. nemorosa (new state record for New Mexico)—8(1):271
Duchesnea indica—8(1):83
Echinacea—8(1):87
Ecology and Conservation (Mojave Desert, U.S.A.)—8(1):175
Ecuador—8(2):511
Prov. Sucumbíos—8(1):37
El Salvador—8(2):595, 603
Encephalartos ferox—8(2):533
Erigeron
compositus (new state record for New Mexico)—8(1):271
nivalis (new state record for New Mexico)—8(1):271
Eugenia dipetala—8(2):**502**
Euphorbia—8(1):85
ouachitana—8(1):85
Euphorbiaceae—8(1):85, 165
Fabaceae—8(1):61, 71, 175; 8(2):511
Florida (U.S.A.)—8(1):227; 8(2):403
Flush Colors—8(2):531
Fort Moultrie (South Carolina, U.S.A.)—8(1):319
Fort Polk (Louisiana, U.S.A.)—8(1):253, 261
Fort Sumter (South Carolina, U.S.A.)—8(1):319
Galveston Island State Park (Texas, U.S.A.)—8(1):339
Galvezia
elisensii—8(1):49
fruticosa—8(1):49
grandiflora—8(1):49
leucantha—8(1):49
leucantha subsp. porphyrantha—8(1):54
leucantha subsp. pubescens—8(1):54
speciosa—8(1):47
Garnotia—8(2):517
variyamensis—8(2):**517**
Gasteroid Fungus—8(1):139
Genetic Diversity—8(1):305
Gentiana aquatica (new state record for New Mexico)—8(1):271
Gesneriaceae—8(1):43, 57
Glossoloma ichthyoderma—8(1):45
Glossoloma velutinum—8(1):43
Grasslands (Halophytic)—8(1):151
Gratiola quartermaniae—8(1):333
Greater Antilles—8(2):529
Guadalupe Mountains (Texas, U.S.A.)—8(2):383
Gypsum flora—8(2):383
Halophytic Grasslands—8(1):151
Heliotropium convolvulaceum (new record for Louisiana)—8(1):197
Hexasepalum
angustifolium—8(1):17
teres—8(1):**17**
Hilaria mutica—8(2):583

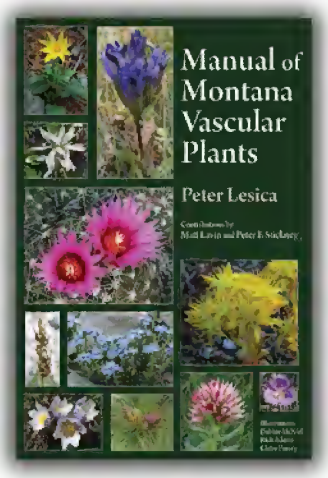
Hydrocharitaceae—8(1):267
Icacinaceae—8(1):169
India—8(1):71, 77; 8(2):517, 523
Jarilla chocola (new record for El Salvador)—8(2):595
Joseph Plains (Idaho, U.S.A.)—8(2):383
Kalamath Region (California)—8(1):9
Kerala (India)—8(2):517, 523
Kobresia
curvata—8(1):77
fragilis—8(1):77
La Sal Mountains (Utah, U.S.A.)—8(2):611
Lactuca biennis (new state record for New Mexico)—8(1):271
Lamiaceae—8(2):431
Leguminosae—8(2):511
Lepidium densiflorum var. macrocarpum (new state record for New Mexico)—8(1):271
Lepidozamia peroffskyana—8(2):533
Loeflingia squarrosa (Arkansas)—8(1):197
Lomatium
bicolor var. leptocarpum—8(2):383
cous—8(2):383
swingerae—8(2):**395**
Lophophora williamsii—8(2):541
Louisiana—8(1):253, 261
Malvaceae—8(1):127
Marantaceae—8(1):31, 37; 8(2):493
McKinney, Landon—8(2):677
Mediterranean-Desert Ecotone (Baja California, Mexico)—8(2):565
Melastomataceae—8(2):457
Melianthiaceae—8(1):253
Mesoamericana, Flora—8(1):31
Mexico—8(2):441
Mexico (Chihuahua)—8(1):151
Miconia—8(2):457
barbata—8(2):**478**
bicolor—8(2):457
bicolor var. **patenti-setosa**—8(2):**474**
cajalbanensis—8(2):**483**
cristalensis—8(2):**485**
guajaibonensis—8(2):**474**
impressa—8(2):**476**
karsticola—8(2):**463**
maestrensis—8(2):**487**
sect. **Miconiastrum**—8(2):**461**
Miconiastrum (sect. of Miconia)—8(2):457
Miconieae (Melastomataceae)—8(2):457
Mid-Tertiary Amber—8(2):551, 559
Miscanthus
sacchariflorus—8(2):637
sinensis (new record for Arkansas)—8(2):637
Mississippi (new state record)—8(1):267
Mistletoe (American)—8(2):641
Mojave Desert (U.S.A.)—8(1):175
Monroe County (Florida, U.S.A.)—8(1):227
Morphology
floral—8(1):127
floral, stem, petiole—8(1):87
Myanmar Amber—8(1):139
Myrcia
cacuminis—8(2):**504**
paulii-jonesii—8(2):**449**
riverae—8(2):**452**
Myrtaceae—8(2):449, 497
Nash Prairie (Texas, U.S.A.)—8(1):381
Nerisyrenia **hypercorax**—8(2):**384**
New Country Records
Brazil (Pleurisanthes flava)—8(1):169
Costa Rica (Astrocasia peltata)—8(1):165
El Salvador (Cuscatlania vulcanicola)—8(2):603
El Salvador (Jarilla chocola)—8(2):595
New Mexico—8(1):271
New State Record for
Arkansas (Canna indica)—8(2):637
Arkansas (Miscanthus sinensis)—8(2):637
Louisiana (Tetragonia tetragonioides)—8(2):661
Louisiana (Dalea lanata)—8(1):197
Louisiana (Heliotropium convolvulaceum)—8(1):197
Mississippi (Blyxa aubertii)—8(1):267
New Mexico (Achnatherum nelsonii var. nelsonii)—8(1):271
New Mexico (Achnatherum nelsonii var. nelsonii)—8(1):271
New Mexico (Artemisia borealis ssp. borealis)—8(1):271
New Mexico (Carex deweyana var. deweyana)—8(1):271
New Mexico (Carex gynocrates)—8(1):271
New Mexico (Carex rosea)—8(1):271
New Mexico (Crepis tectorum)—8(1):271
New Mexico (Cymopterus spellenbergii)—8(1):271
New Mexico (Draba nemorosa var. nemorosa)—8(1):271
New Mexico (Erigeron compositus)—8(1):271
New Mexico (Erigeron nivalis)—8(1):271
New Mexico (Gentiana aquatica)—8(1):271
New Mexico (Lactuca biennis)—8(1):271
New Mexico (Lepidium densiflorum var. macrocarpum)—8(1):271
New Mexico (Paronychia wilkinsonii)—8(2):383
New Mexico (Penstemon glaber var. alpinus)—8(1):271
New Mexico (Polemonium occidentale var. occidentale)—8(1):271
New Mexico (Potentilla fissa)—8(1):271
New Mexico (Ranunculus repens)—8(1):271
New Mexico (Rudbeckia laciniata var. laciniata)—8(1):271
New Mexico (Silene drummondii var. striata)—8(1):271
New Mexico (Syringa vulgaris)—8(1):271
New Mexico (Tripleurospermum inodorum)—8(1):271
North America—8(1):85
North Central New Mexico—8(1):271
Nuevo Leon (Mexico)—8(2):441
Nyctaginaceae—8(2):603
Pacífico Sur de Costa Rica—8(1):19
Palaeogaster—8(1):**140**
micromorpha—8(1):**140**
Panama—8(1):31
Paronychia wilkinsonii (New State Record for New Mexico)—8(2):383
Passiflora
brevifila—8(1):23
soliana—8(1):19
Peninsular Florida (U.S.A.)—8(2):403
Penstemon glaber var. alpinus (new state record for New Mexico)—8(1):271
Peru—8(1):47, 57
Phanera glauca subsp. **tenuiflora** var. **gandhiana—8(1):71**
Phoradendron leucarpum ssp. leucarpum—8(2):641
Plantaginaceae—8(1):47, 333
Pleurisanthes flava (new record for Brazil)—8(1):169
Plinia ambivalens—8(2):**507**
Poaceae—8(2):517, 523, 583
Polemonium occidentale var. occidentale (new state record for New Mexico)—8(1):271
Potentilla fissa (new state record for New Mexico)—8(1):271
Potentilleae—8(1):83
Prosopis—8(1):175
Ranunculus repens (new state record for New Mexico)—8(1):271
Red River (Arkansas, U.S.A.)—8(1):197
Reed Plateau (Texas, U.S.A.)—8(1):359
Rhamnaceae—8(2):551
Rocky Mountains (U.S.A.)—8(2):611
Rosaceae—8(1):83
Rubiaceae—8(1):17; 8(2):529
Rudbeckia laciniata var. laciniata (new state record for New Mexico)—8(1):271
San Francisco Peaks (Arizona, U.S.A.)—8(2):611
Sangre de Cristo Mountains (New Mexico)—8(1):271
Sapotaceae—8(2):403
Sedum kiersteadiae—8(1):9
Senegalia
harleyi—8(1):64
hatschbachii—8(1):66
irwinii—8(1):62
Sida—8(1):127
regnellii—8(1):127
rhombifolia—8(1):127
urens—8(1):127
Sierra Madre Oriental (Mexico)—8(2):441
Silene
drummondii var. striata (new state record for New Mexico)—8(1):271
hitchguirei (new state record for New Mexico)—8(1):271

Skkim (India)—8(1):77
Solanaceae—8(1):1
Solanum—8(1):1
angustifolium—8(1):6
angustifolium—8(1):7
citrullifolium—8(1):6
cordicitum—8(1):**2**
cordicitum—8(1):7
davisens—8(1):6
fructo-tecto—8(1):6
grayi—8(1):7
heterodoxum—8(1):7
johnstonii—8(1):6
knoblochii—8(1):**5**
knoblochii—8(1):6
leucandrum—8(1):7
lumholtzianum—8(1):7
novomexicanum—8(1):**6**
rostratum—8(1):6
setigeroides—8(1):**5**
setigeroides—8(1):6
tenuipes—8(1):6
tribulosum—8(1):6
South Carolina (U.S.A.)—8(1):319; 8(2):431
South Texas (U.S.A.)—8(2):541
Southern Rocky Mountains (U.S.A.)—8(2):611
Stachys
arenicola—8(2):431
aspera—8(2):431
caroliniana—8(2):**431**
pilosa—8(2):431
Stipulicida—8(2):419
lacerata—8(2):**426**
Sucumbíos (Prov. In Ecuador)—8(1):37
Syringa vulgaris (new state record for New Mexico)—8(1):271
Tallgrass Prairie (Colorado, U.S.A.)—8(1):203
Tertiary amber—8(1):145
Tetragonia tetragonioides (new record for Louisiana)—8(2):661
Texas (U.S.A.)—8(1):2, 333, 339, 359, 381; 8(2):665
Ticodendraceae—8(2):559
Ticodendron—8(2):559
palaios—8(2):**560**
Tithymalus (sect.)—8(1):85
Tripleurospermum inodorum (new state record for New Mexico)—8(1):271
Tripogon
malabarica—8(2):**523**
Tripogoninae—8(2):523
Umbelliferae—8(2):383
Utah (U.S.A.)—8(2):611
Uvularia sessilifolia—8(1):261
Valle de Janos (Mexico)—8(1):151
Viscaceae—8(2):641
Wandersong—8(2):**530**
exserta—8(2):**530**
seminervis—8(2):**530**
Wetlands (Colorado, U.S.A.)—8(1):203
Xylaria antiqua—8(1):146
Xylariaceae—8(1):145
Zacatal de Toboso—8(2):583
Zamia—8(2):531
Zigadenus densus—8(1):253

52 New names and New Combinations: Volume 8 (2014)

Agave × madrensis Villarreal, A. Ramírez, & A.E. Estrada, hybrid nov.—**8(2):443**
Browneopsis puyensis D.A. Neill & Asanza, sp. nov.—**8(2):511**
Calathea
cofaniorum H. Kenn., sp. nov.—**8(1):37**
gordonii H. Kenn., sp. nov.—**8(1):31**
rubribracteata H. Kenn., sp. nov.—**8(2):493**
shishicoensis H. Kenn., sp. nov.—**8(1):41**
Calyptranthes
solitaria Sobral, Aguiar, & Antunes, sp. nov.—**8(2):498**
ubatubana Sobral & Rochelle, sp. nov.—**8(2):500**
Cremosperma inversum B.R. Keener & J.L. Clark, sp. nov.—**8(1):57**
Cyperus stewartii G.C. Tucker, sp. nov.—**8(1):25**
Distigouania K.L. Chambers & Poinar, gen. nov.—**8(2):552**
irregularis K.L. Chambers & Poinar, sp. nov.—**8(2):552**
Eugenia dipetala Sobral & Kollmann, sp. nov.—**8(2):502**
Galvezia elisensii M.O. Dillon & Quipuscoa, sp. nov.—**8(1):49**
Garnotia variyamensis Sunil, Naveen Kumar, & Sanilkumar, sp. nov.—**8(2):517**
Glossoloma velutinum J.L. Clark & L.A. Rodas, sp. nov.—**8(1):43**
Hexasepalum teres (Walter) J.H. Kirkbr., comb. nov.—**8(1):17**
Lomatium swingerae R.P. McNeill, sp. nov.—**8(2):395**
Miconia
barbata (Borhidi) Judd, Bécquer, & Majure, comb. nov.—**8(2):478**
bicolor var. **patenti-setosa** (Borhidi) Judd, Bécquer, & Majure, comb. nov.—**8(2):474**
cajalbanensis Judd, Bécquer, & Majure, nom. nov.—**8(2):483**
cristalensis (Borhidi) Judd, Bécquer, & Majure, comb. nov.—**8(2):485**
guajaibonensis Judd, Bécquer, & Majure, nom. nov.—**8(2):474**
impressa (Urb.) Judd, Bécquer, & Majure, comb. nov.—**8(2):476**
karsticola Judd, Bécquer, Skean, & Majure, nom. nov.—**8(2):463**
maestrensis Judd, Bécquer, & Majure, nom. nov.—**8(2):487**
Miconia sect. **Miconiastrum** (Bonpl. ex Naudin) Judd, Bécquer, & Majure, comb. nov.—**8(2):461**
Myrcia
cacuminis Kollmann & Sobral, sp. nov.—**8(2):504**
paulii-jonesii Aguilar, D. Santam., & A. Estrada, sp. nov.—**8(2):449**
riverae A. Estrada, D. Santam., & Aguilar, sp. nov.—**8(2):452**
Nerisyrenia hypercorax P.J. Alexander & M.J. Moore, sp. nov.—**8(2):384**
Palaeogaster Poinar, Alfredo, & Baseia, gen. nov.—**8(1):**140
micromorpha Poinar, Alfredo, & Baseia, sp. nov.—**8(1):**140
Passiflora soliana A. Estrada & G. Rivera, sp. nov.—**8(1):19**
Phanera glauca subsp. **tenuiflora** var. **gandhiana** Gogoi & Bandyop., var. nov.—**8(1):**71
Plinia ambivalens M. Souza & Sobral, sp. nov.—**8(2):507**
Sedum kiersteadiae B.L. Wilson & R.E. Brainerd, sp. nov.—**8(1):9**
Senegalia
harleyi Seigler, Ebinger, & P.G. Ribeiro, sp. nov.—**8(1):64**
hatschbachii Seigler, Ebinger, & P.G. Ribeiro, sp. nov.—**8(1):66**
irwinii Seigler, Ebinger, & P.G. Ribeiro, sp. nov.—**8(1):62**
Solanum
cordicitum S. Stern, sp. nov.—**8(1):2**
knoblochii (Whalen) S. Stern, comb. & stat. nov.—**8(1):5**
novomexicanum (Bartlett) S. Stern, comb. & stat. nov.—**8(1):6**
setigeroides (Whalen) S. Stern, comb. & stat. nov.—**8(1):5**
Stachys caroliniana J.B. Nelson & D.A. Rayner, sp. nov.—**8(2):431**
Stipulicida lacerata (C.W. James) D.B. Poind., K.E. Bennett, & Weakley, comb. et stat. nov.—**8(2):426**
Ticodendron palaios K.L. Chambers & Poinar, sp. nov.—**8(2):560**
Tripogon malabarica Thoiba & Pradeep, sp. nov.—**8(2):523**
Wandersong D.W. Taylor, gen. nov.—**8(2):530**
exserta (DC.) D.W. Taylor, comb. nov.—**8(2):530**
seminervis (Urb. & Ekman) D.W. Taylor, comb. nov.—**8(2):530**
Xylaria antiqua Poinar, sp. nov.—**8(1):**146

New Titles from BRIT Press



Manual of Montana Vascular Plants

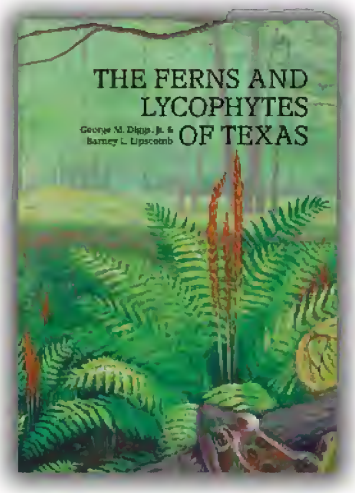
August 2013

Second printing with corrections and errata, 28 May 2014

Montana is the fourth largest state in the United States. It includes portions of the Northern Great Plains and the Rocky Mountains. The vegetation of Montana is diverse, due primarily to the size of the state and its great topographic relief which provide strong variation in environmental factors. Montana has a relatively large flora for a northern continental region due to being at the intersection of the Cordilleran, Great Plains and Boreal floristic provinces. This book is a comprehensive field guide to the more than 2,500 species of Montana's vascular plants. It contains descriptions as well as habitat and distribution information based on specimens housed at the states two major herbaria. Portraits or illustrations of diagnostic structures are provided for nearly one-third of the species.

Lesica, P., with contributions by M. Lavin and P.F. Stickney. Illustrations by Debbie McNiel, Rich Adams, Claire Emery. 2012 (2nd printing with corrections/errata). ***Manual of Montana Vascular Plants.*** (ISBN-13: 978-1-889878-39-3, pbk.). Botanical Research Institute of Texas Press, 1700 University Dr., Fort Worth, Texas 76107-3400, U.S.A. (**Orders:** shop.brit.org, orders@brit.org, 817-332-4441 ext. 264, fax 817-332-4112). $55.00, 6.5"×9.5" (pbk), 780 pp., 2000 + maps + 128 plates. $6.00 shipping ($3.00 each additional copy), outside the U.S.A. contact orders@brit.org, Texas residents add 8.25% ($5.03) to subtotal including postage for each book.

The Ferns and Lycophytes of Texas



February 2014

Texas has a surprising number of native ferns and lycophytes—127 in all, the most of any state in the continental U.S.A. This is particularly unexpected given that most people associate ferns and related plants with humid, even tropical, conditions, just the opposite of much of Texas. This book explains why and looks at the fascinating world of Texas ferns, ranging from the swamp forests of far East Texas, to the hidden canyons of the Edwards Plateau, and even to the high mountain "sky islands" of such places as Big Bend National Park. Each species has an illustration page with a color photo, a line drawing, and detailed maps. Be ready to be surprised by this special group of Texas plants.

George M. Diggs, Jr. and Barney L. Lipscomb. ***The Ferns and Lycophytes of Texas.*** (ISBN-13: 978-1-889878-37-9, flexbound). Botanical Research Institute of Texas Press, 1700 University Dr., Fort Worth, Texas 76107-3400, U.S.A. (**Orders:** shop.brit.org, orders@brit.org, 817-332-4441 ext. 264, fax 817-332-4112). $29.95, 392 pp., color photos, distribution maps, 7"×10". $4.50 shipping ($3.00 each additional copy), outside the U.S.A. contact orders@brit.org, Texas residents add 8.25% ($2.43) to subtotal including postage for each book.

BRIT PRESS For more information on these titles and others, please visit us at shop.brit.org.

Journal of the Botanical Research Institute of Texas

The *Journal of the Botanical Research Institute of Texas*, formerly called *Sida, Contributions to Botany*, publishes research in classical and modern systematic botany—including studies of anatomy, biogeography, chemotaxonomy, ecology, evolution, floristics, genetics, paleobotany, palynology, and phylogenetic systematics. Geographic coverage is global. Articles are published in either English or Spanish; an abstract is provided in two languages. All contributions are peer reviewed and frequently illustrated with maps, line drawings, and full color photographs.

The journal is published twice yearly in a multiple topic format and provides information to scientists, professionals, and the general public for research, education, and cultural enhancement. All articles are indexed and abstracted in print and/or electronic form by the following: AGRICOLA Database (National Agricultural Library); Applied Botany Abstracts; Biosciences Information Service of Biological Sciences (BIOSIS); Current Awareness in Biological Sciences (CABS); ISI Thomson; The Kew Record of Taxonomic Literature; Natural Products Alert (NAPRALERT); Scopus® database, SCImago Journal and Country Rank (Elsevier B.V.); and Referativnyi Zhurnal (Abstracts Journal of the Institute of Scientific Information of the Republic of Russia).

Lloyd H. Shinners, whose herbarium and library were the basis of the Southern Methodist University (SMU) legacy that became BRIT in 1987, founded the journal in 1962. **William F. Mahler** succeeded Shinners as SMU herbarium director in 1971 and inherited both ownership and editorship of the journal. Since 1993, it has been published by the Botanical Research Institute of Texas.

ISSN 1934-5259

Journal of the Botanical Research Institute of Texas

Volume 8(2): 383–685. 2014

BRIT PRESS